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ONR ltr, 31 Jan 2006

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ACOUSTIC EVALUATION OF SANDERS ASSOCIATES ACODAC SENSORS

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Warminster, PA 18974

March 1983

PHASE REPORT

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18. SUPPLEMENTARY NOTES

Appendix A

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Acoustic
Evaluation
ACODAC
Sensors

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Two Sanders Associates Incorporated pressure gradient directional sensors capable of deep ocean operation were evaluated at the NAVAIRDEVCEN'S Open Water Facility under simulated acoustical and environmental conditions. Measured acoustic performance was satisfactory except for narrow frequency bands where the directivity and receiving response were degraded.

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SUMMARY

BACKGROUND

The Naval Air Development Center was tasked by the Naval Electronic Systems Command (NAVELEX) (PME-124-30) to evaluate Sanders Associates, Incorporated, directional sensor (hydrophone) for compliance with NAVELEX Specification ELEX-B-409 of 17 June 1980. This report presents measured data on two redesigned Acoustic Data Capsule (ACODAC) sensors (AC-1, AC-2) and performance evaluation on one of these sensors (AC-2). These sensors, submitted by the contractor were acoustically measured at the NAVAIRDEVCEN Open Water Facility.

RESULTS

Analysis of the measured data relative to the specification requirements indicates satisfactory acoustic performance with two exceptions: narrow frequency regions in the analysis band where response anomalies occurred and directivity performance was degraded with nulls depths of about -21 dB. The redesigned ACODAC sensors submitted by Sanders Associates, although displaying superior acoustic performance compared to units previously submitted, still have minor specification deficiencies in both the receiving and directivity responses.

RECOMMENDATION

It is recommended that Sanders investigate the sine/cosine response and directivity specification deficiencies and develop a positive approach to correct this hydrophone design problem area.

DISCUSSION

INTRODUCTION

This report presents the evaluation of two ACODAC sensors submitted by Sanders Associates, Incorporated. Acoustic performance evaluation criteria is based on table I. Both the directional and omnidirectional hydrophone elements within these sensors were evaluated for receiving voltage, phase, and directivity response. Environmental testing was conducted under ambient to 8000 psig pressure and at 6 degrees centigrade temperature.

SENSOR DESIGN AND DESCRIPTION

The basic sensor design is shown in figure 1 and consists of a neutrally-buoyant canister containing two orthogonal pair of electrodynamic geophones and one bottom-mounted ceramic disc element. The sensors were designated AC-1, 2 (NADC Code-225-1, 2) and represent a redesign of the original ACODAC sensor. Only AC-2, however, has the internal design improvements which Sanders is currently recommending. This unit, containing both the directional and omnidirectional sensors, has newer geophones and ruggedized machined aluminum straps and saddle to properly secure the geophones, thereby minimizing spurious resonances. A complete acoustic data package and evaluation are presented herein on this unit.

The AC-1 sensor contains only the directional sensors and utilizes 1/16 inch thick steel straps to secure the geophones. Sanders subsequently rejected this securing technique because of its susceptibility to in-band resonances. Although this unit was primarily submitted for sensor flow-noise evaluation, some acoustic calibration tests were initially performed indicating a defective cosine channel. It was decided to curtail further acoustic evaluation of this sensor and prepare it for the required flow-noise evaluation by replacing the defective geophones in the cosine channel. For completeness, the initial acoustic data taken on AC-1 is attached as appendix A.

MEASURED DATA RESULTS

Directional Receiving Response

Measured receiving response data for AC-2 is presented in figure 2. Measurements were made on the Maximum Response Axis (MRS) and at 80 deg off the MRA. Both the cosine and the sine channels displayed essentially flat response with a low frequency roll off starting at about 20 Hz and an upper resonance at 3300 Hz. The sensitivity at 100 Hz is nominally -204 dB/volt/uP with cosine to sine amplitude tracking within ± 1.0 dB. Evaluation of the off-axis response (80 deg) revealed narrow regions of response anomalies in the low (34 Hz), mid (170, 200 Hz) and upper (2000-2500 Hz) frequencies where the directivity performance was degraded.

Omnidirectional Receiving Response

The omnidirectional receiving response is presented in figure 3 and shows an essentially flat response over the analysis band with a minor resonance at 3500 Hz. The nominal sensitivity is -195 dB/volt/uP, without the internal preamplifier.

Phase Response

Cosine-to-sine phase response for AC-2 is presented in figure 4. Phase tracking is within the 15 deg. requirement over the analysis band. It was not possible to measure the phase response between the directional and omnidirectional sensors because of crosstalk induced from the amplified omnidirectional channel. To simulate this, phase measurements were taken comparing each directional channel with the output of a flat reference hydrophone with both sensors equidistant from the sound source. The results, presented in figure 5 show close directional-to-omnidirectional tracking (±7°) with no abrupt deviations. This implies that post sensor electronics can be utilized to achieve the 20 deg. directional to omnidirectional phase tracking requirement.

Directivity Patterns

Directivity patterns on the AC-2 directional channels are presented in figures 7 through 24 and summarized in table II. The analyzed data show that the required directivity performance is not met in the frequency regions of 34 Hz, 170 Hz, 200 Hz, and above 2000 Hz. Null depths in these regions do not meet the -30 dB relative to MRA requirement. Null depth in the degraded region is typically -21 dB.

Hydrostatic Pressure Testing

Hydrostatic pressure response data was taken on the directional and omnidirectional sensors of AC-2 up to 8000 PSIG. To minimize problems associated with entrapped air bubbles, a vessel pressure of 500 PSIG was used as the baseline reference with response changes noted at 1000 PSIG, 4000 PSIG, and 8000 PSIG. For the omnidirectional sensor this change is plotted in figure 6. The data shows no pressure-related changes in excess of 2 dB; therefore, the omnidirectional sensor is adequate.

Pressure response data on the directional channels was limited to specific frequency regions: nominally 25 Hz to 200 Hz and 600 Hz to 900 Hz. Frequencies outside these regions were contaminated by vessel structural resonances which tended to mask directional sensor performance. There were, however, no clearly discernible changes in the directional channel response as a function of hydrostatic pressure. This was expected since the geophone elements are mechanically isolated from the hydrostatic pressure.

Problem Areas Identified

The redesigned ACODAC sensor (AC-2) failed to meet the acoustic performance requirements in one critical area; hydrophone directivity. Null depth deficiencies were observed in narrow frequency regions within the analysis band.

One additional hardware-related problem area was identified. The plastic bulkhead electrical connector (BEACON, BRANTNER & Associates) failed twice and had to be replaced. Similar failures have been reported by Sanders personnel. Use of these inexpensive connectors on prototype hardware is not cost-effective; any repair becomes labor intensive and easily justifies the more rugged bulkhead connector planned for the production buoy.

CONCLUSIONS

The redesigned ACODAC sensor displayed superior acoustic performance over units previously evaluated at the NAVAIRDEVCEN. Minor directivity deficiencies were noted in specific frequency regions of the analysis band for the directional sensors.

RECOMMENDATIONS

Sanders Associates should review the directional performance of the ACODAC sensor to insure that acceptable and consistent directivity is achieved over the analysis band. Assuming this is a geophone-related problem, two corrective approaches are recommended:

1. use a higher quality, anomaly-free geophone,

2. bench-test all geophones to enable selection of element pairs free of anomalies.

It is further recommended that additional prototype ACODAC sensors be fitted with ruggedized bulkhead connectors to minimize mechanical failures during contractor in-house or NAVAIRDEVCEN evaluations.

TABLE I

REQUIRED PERFORMANCE FOR SANDERS ACODAC SENSOR

ACOUSTIC PARAMETERS EVALUATED	SPECIFICATION CRITERIA	ACCEPTABLE CRITERIA (INCLUDES CALIBRATION ACCURACY)
Receiving Response Shape at MRA	Figure 1	Smooth flowing and free of anomalies
Sine to Cosine Sensitivity Tracking	±1.0 dB	±2 dB
Mean Directional to Omni-directional Sensitivity Tracking	±3.0 dB	Suitable for tracking via post-sensor electronic adjustment
Sine to Cosine Phase Tracking	15°	20°
Directional to Omnidirectional Phase Tracking	20°	Suitable for tracking via post-sensor electronic adjustment
Sensitivity Losses under 8000 PSIG pressure	-1.0 dB	-2.0 dB
Directional Patterns:		
a. Sensitivities for azimuth 70° from MRA	cosine ±1.0 dB	cosine ±2.0 dB
b. Sensitivities for azimuth 70° from MRA	*-8 dB/MRA	-7 dB/MRA
c. Null depths to MRA sensitivity	-30 dB	-28 dB
Omnidirectional Pattern	Omnidirectional ±1.0 dB	Omnidirectional ±2.0 dB

*This specification criteria is based on an ideal cosine pattern being -9.0 dB/MRA sensitivity at 70 degrees azimuth.

TABLE II

DIRECTIVITY PATTERN SUMMARY FOR SANDERS ACODAC SENSORS (AC 2)

FIGURE	FREQUENCY IN DB	MINIMUM NULL DB RELATIVE TO MAIN AXIS	SINE/COSINE NORMALITY DEVIATION IN DEGREES	ACCEPTABLE
Ideal	Analysis Band	-28	6 (±3)	Yes
7	10	--	5½	Yes
8	30	-29	5½	Yes
9	34	-21	4½	No
10	50	--	5	Yes
11	100	--	6	Yes
12	135	--	5	Yes
13	150	--	5½	Yes
14	170	-21	6	No
15	180	--	6	Yes
16	200	-25	6	No
17	250	-32	3½	Yes
18	500	-30	4	Yes
19	750	-28	3½	Yes
20	1000	--	3½	Yes
21	1500	-33	3	Yes
22	2000	-20	2½	No
23	2300	-22	4	No
24	2500	-24	4½	No

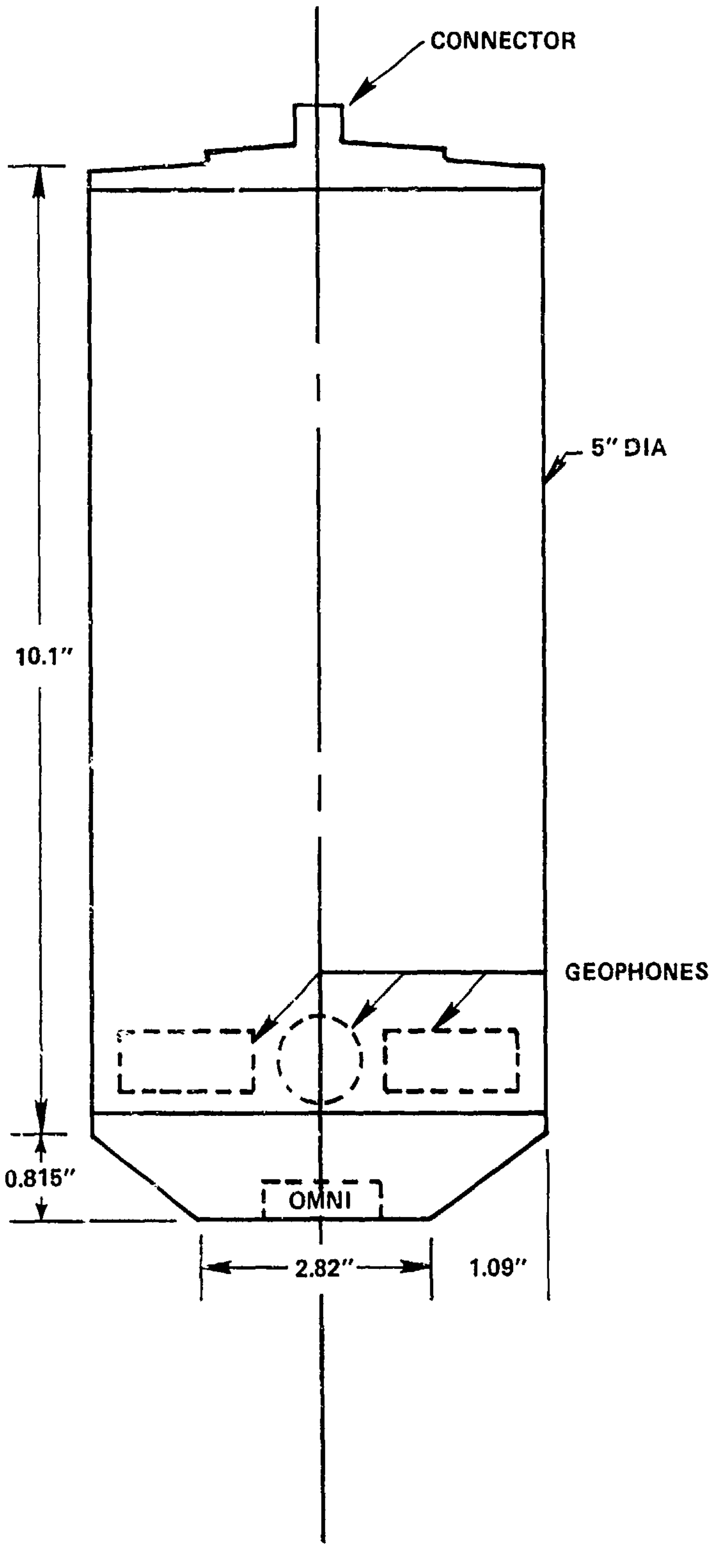
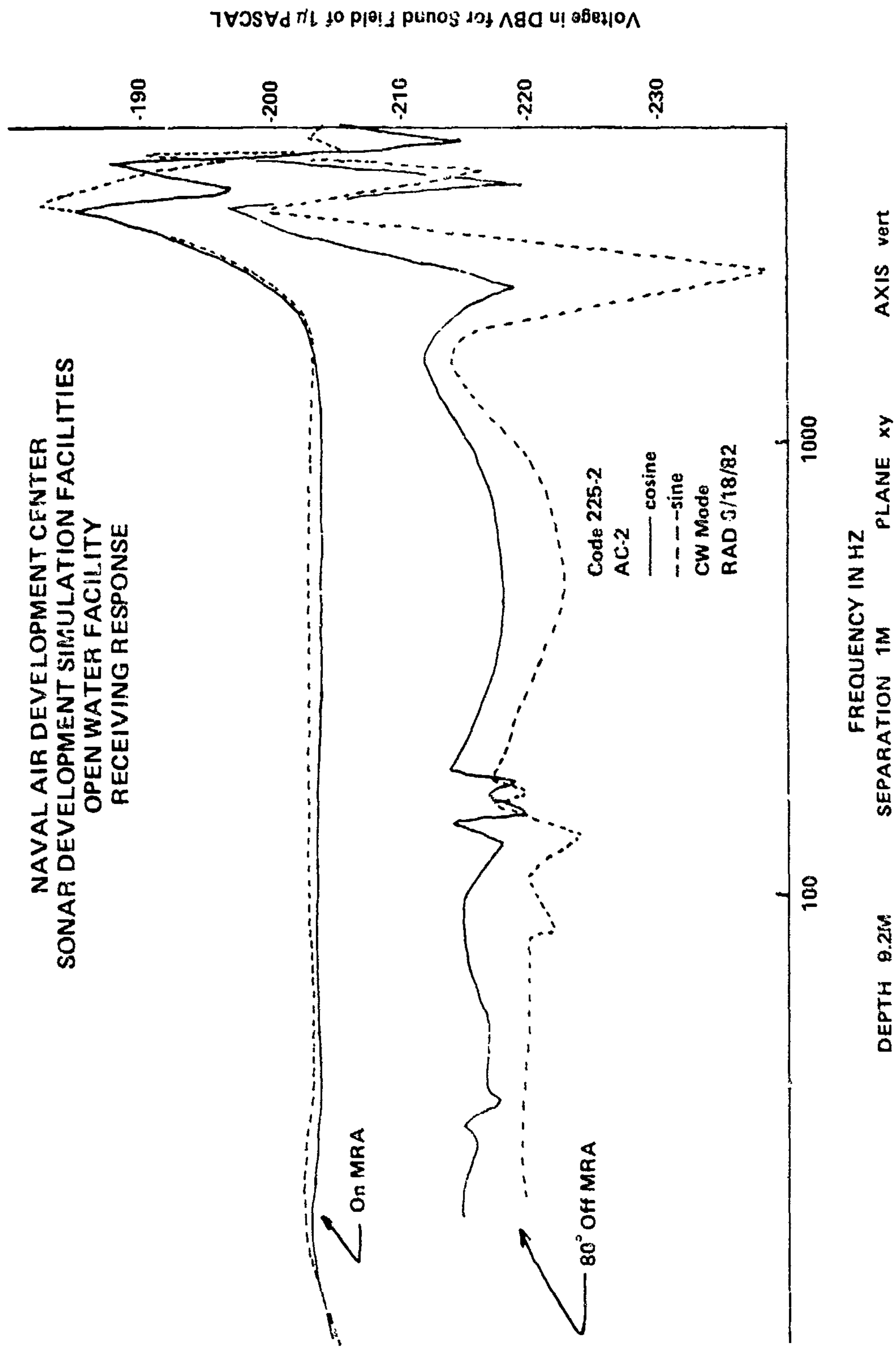


Figure 1



NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES
OPEN WATER FACILITY
RECEIVING RESPONSE
Voltage in DBV for Sound Field of 1μ PASCAL
-190
-200
-210
-220
-230
100
1000
FREQUENCY IN HZ
DEPTH 9.2M SEPARATION 1M PLANE xy AXIS vert
Code 225-2
AC-2
cosine
sine
CW Mode
RAD 3/18/82
On MRA
80° Off MRA

Figure 2

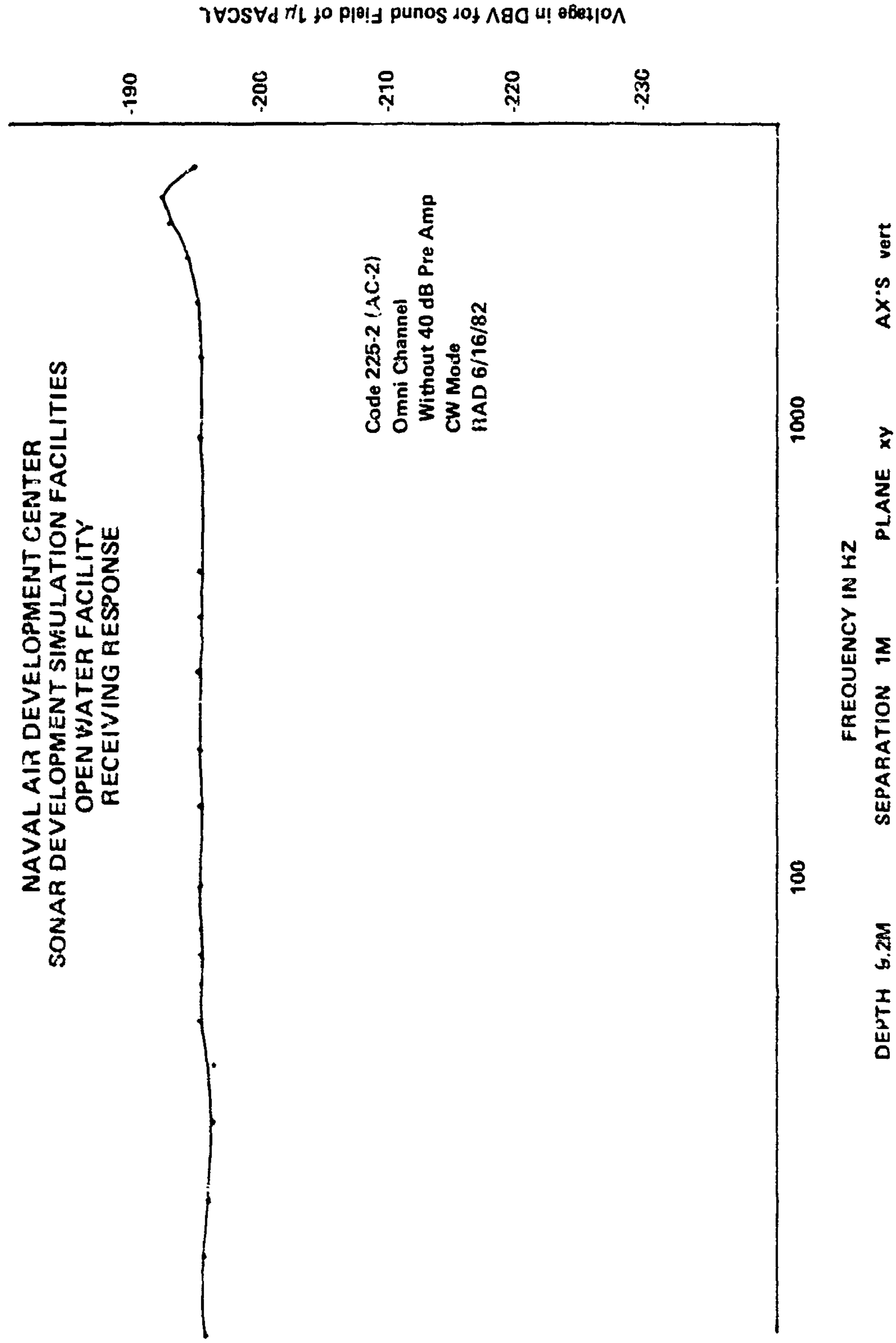

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES
OPEN WATER FACILITY
RECEIVING RESPONSE
Voltage in DBV for Sound Field of 1μ PASCAL
-190
-200
-210
-220
-230
Code 225-2 (AC-2)
Omni Channel
Without 40 dB Pre Amp
CW Mode
RAD 6/16/82
100
1000
FREQUENCY IN HZ
DEPTH 9.2M
SEPARATION 1M
PLANE xy
AXIS vert

Figure 3

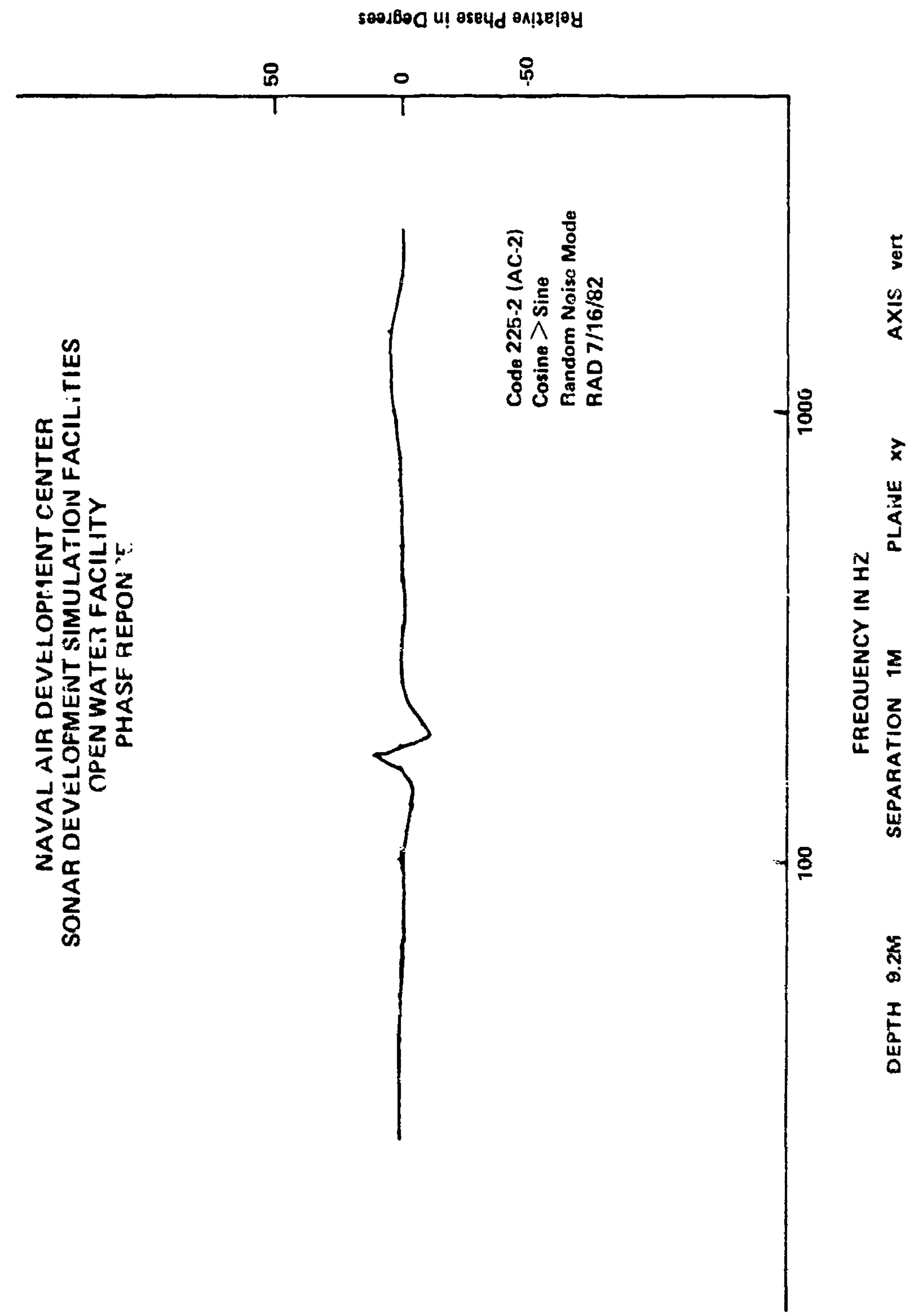

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES
OPEN WATER FACILITY
PHASE REPONSE
Relative Phase in Degrees
50
0
-50
Code 225-2 (AC-2)
Cosine > Sine
Random Noise Mode
RAD 7/16/82
100
1000
FREQUENCY IN HZ
DEPTH 9.2M
SEPARATION 1M
PLANE xy
AXIS vert

Figure 4

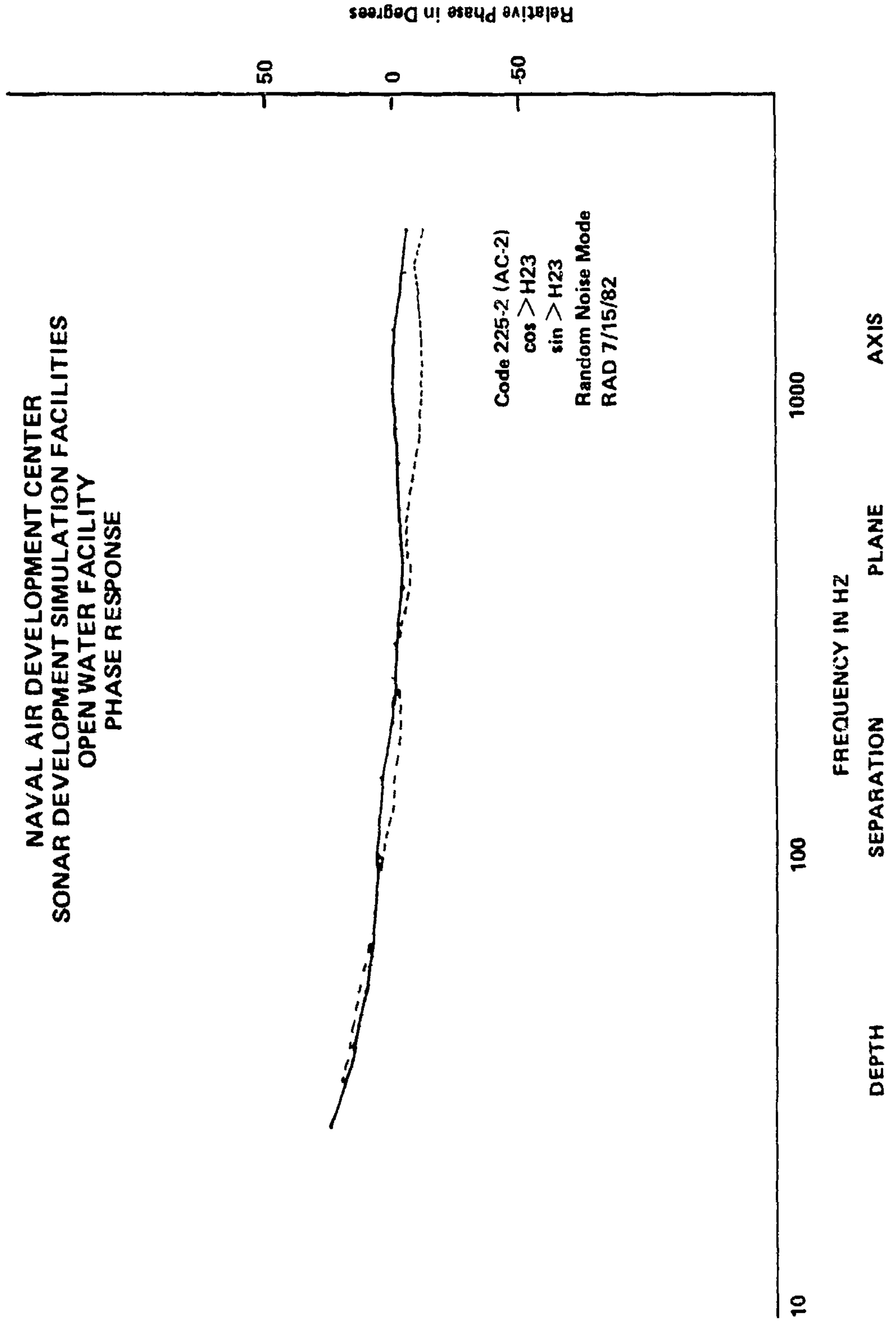

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES
OPEN WATER FACILITY
PHASE RESPONSE
Relative Phase in Degrees
50
0
-50
Code 225-2 (AC-2)
cos > H23
sin > H23
Random Noise Mode
RAD 7/15/82
10
100
1000
FREQUENCY IN HZ
DEPTH
SEPARATION
PLANE
AXIS

Figure 5

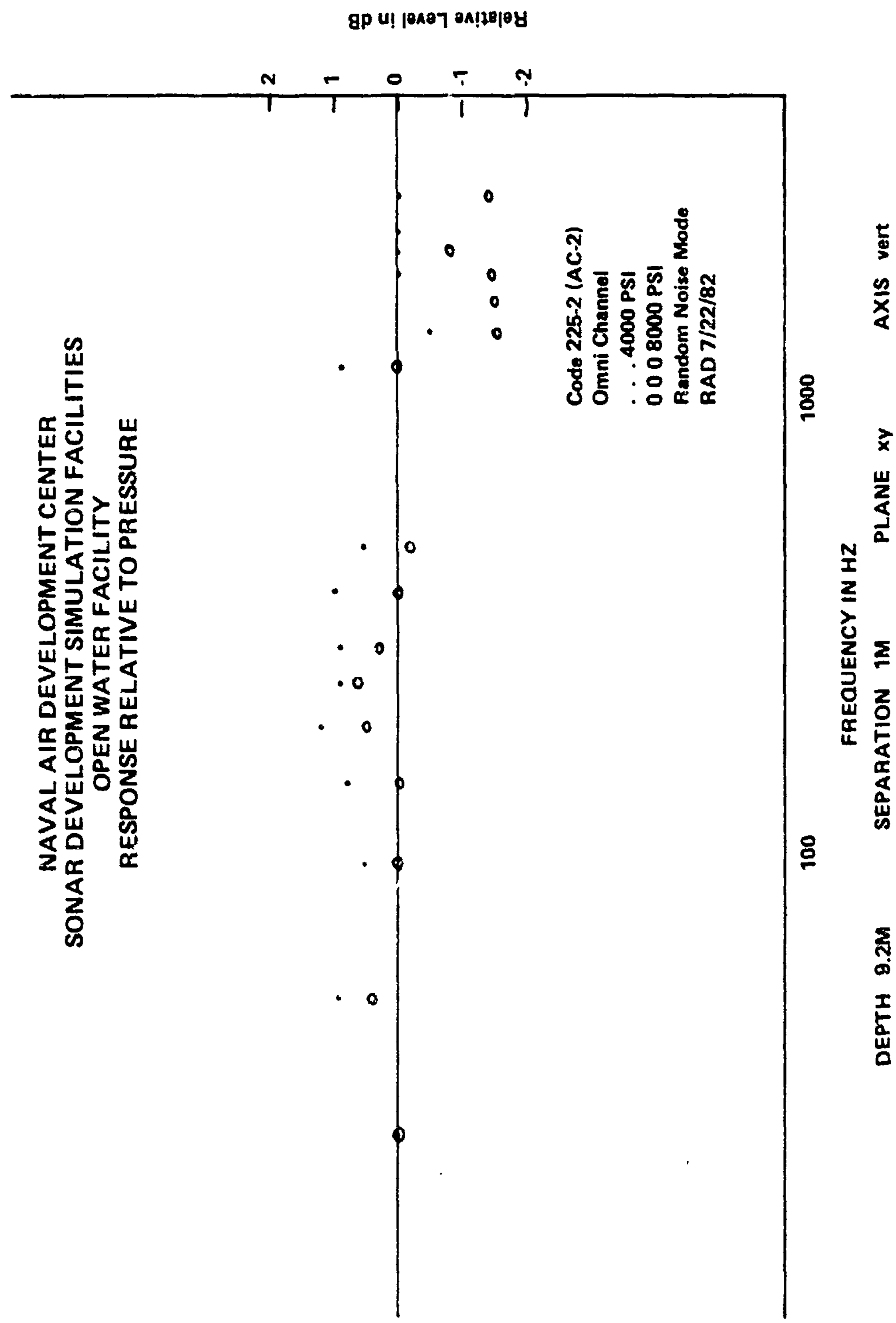
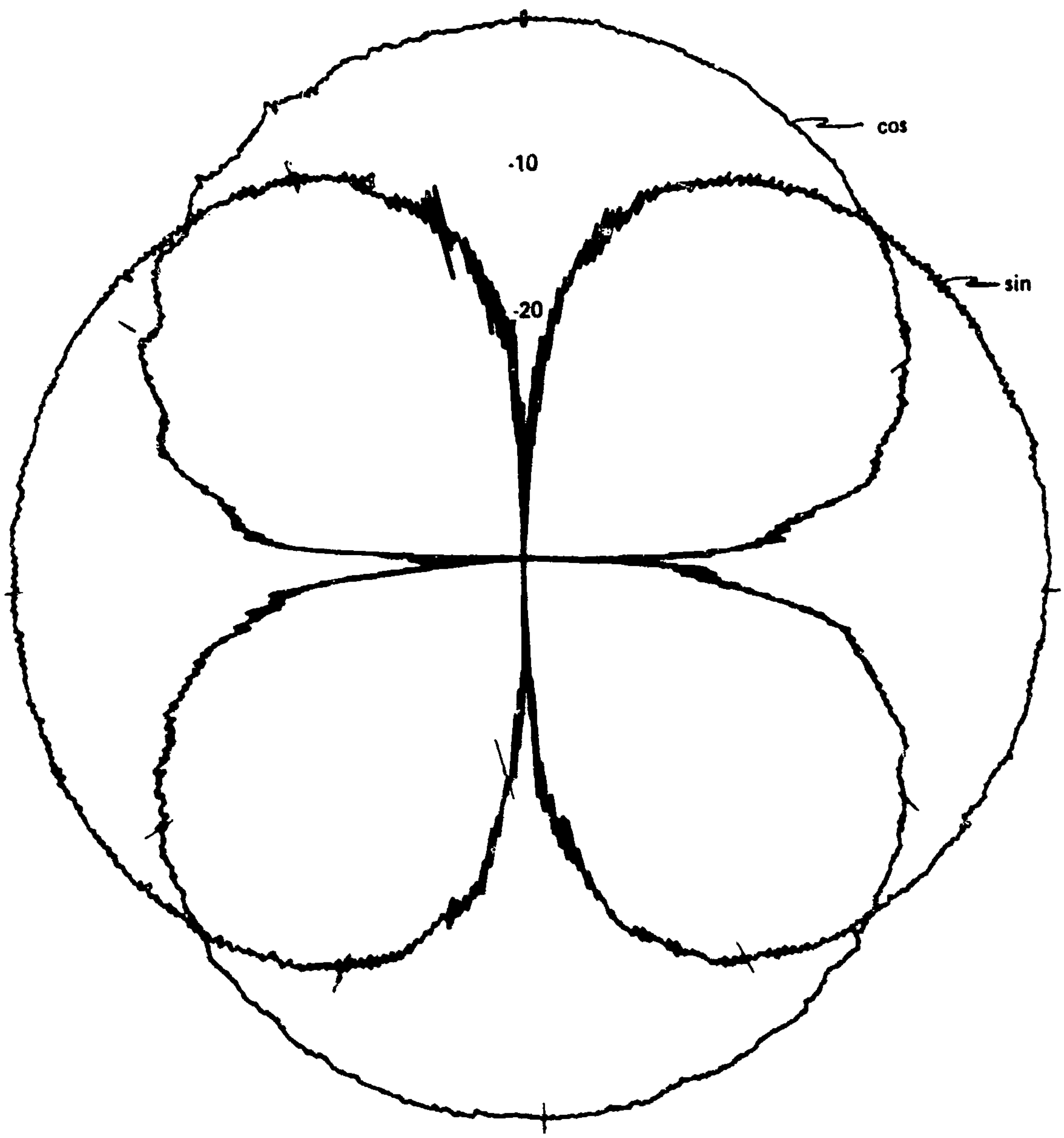

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES
OPEN WATER FACILITY
RESPONSE RELATIVE TO PRESSURE
Relative Level in dB
2
1
0
-1
-2
Code 225-2 (AC-2)
Omni Channel
. . . 4000 PSI
0 0 0 8000 PSI
Random Noise Mode
RAD 7/22/82
100
1000
FREQUENCY IN HZ
DEPTH 9.2M
SEPARATION 1M
PLANE xy
AXIS vert

Figure 6

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



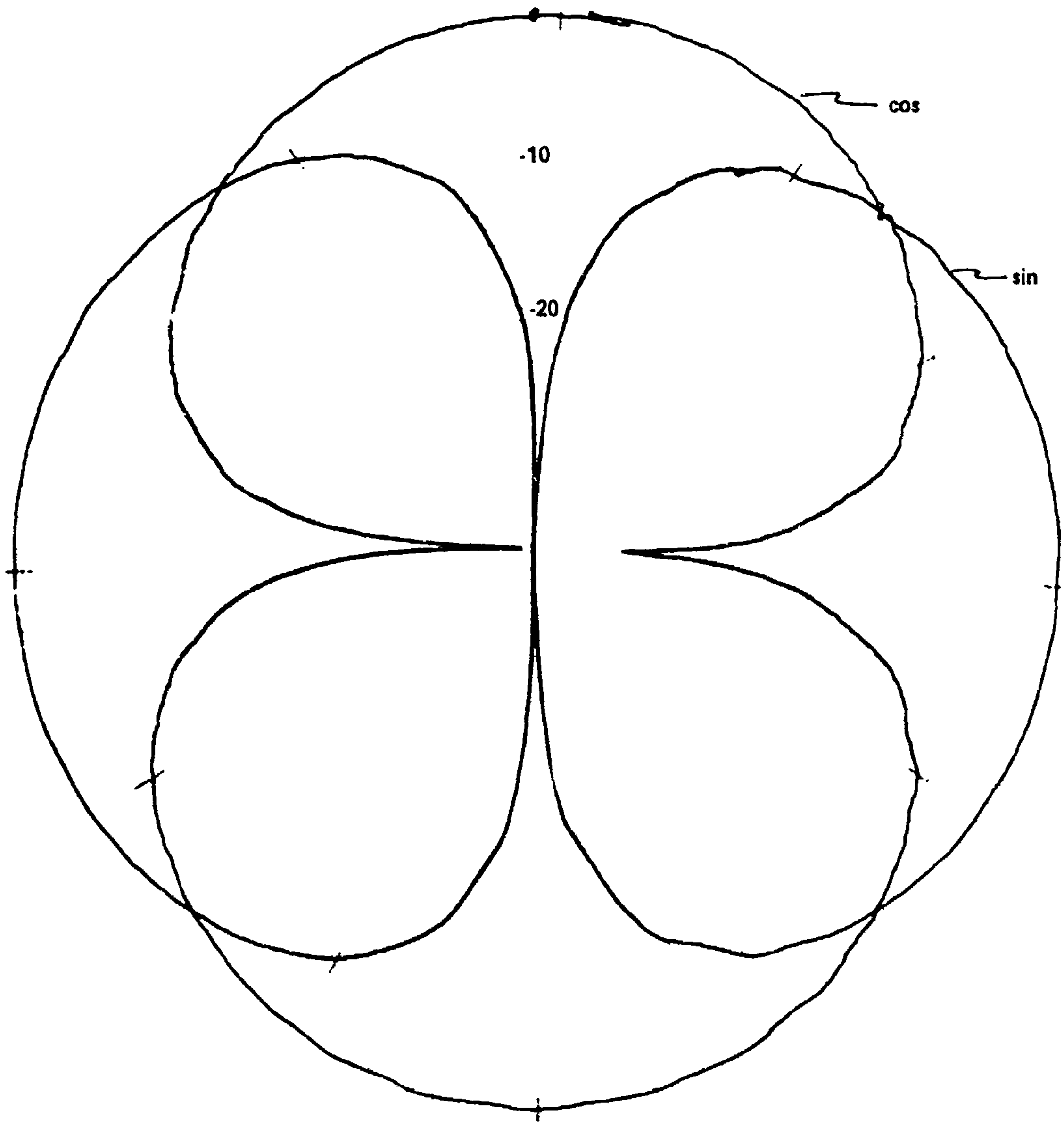
MODE	cw	TEST UNIT	Code 225-2 (AC-2)
PLANE	xy	FREQ/HZ	10
DEPTH	9.2M	DATE	6/17/82
SEPARATION	1M	TST ENGR	RAD

Figure 7

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



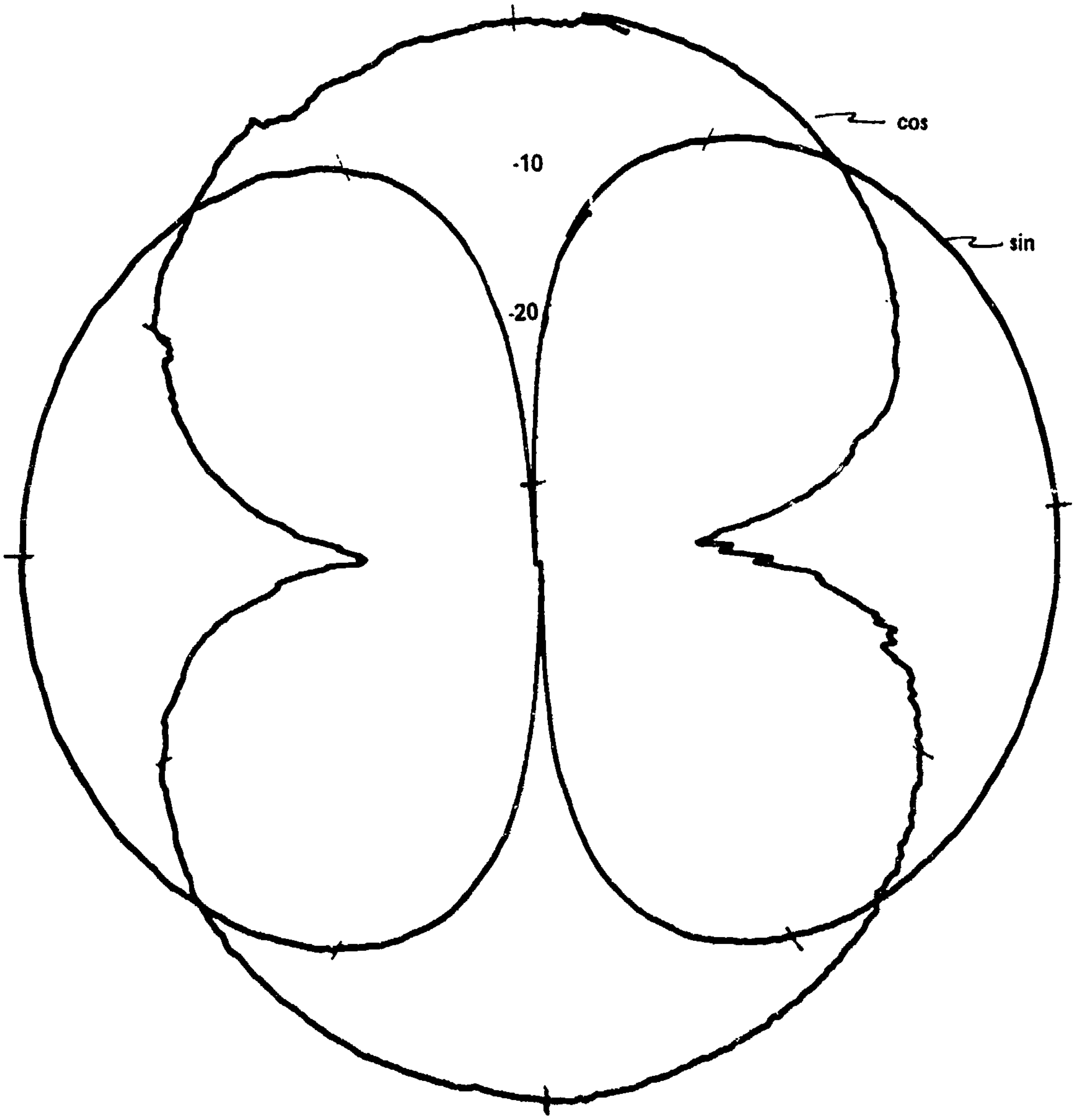
MODE	cw	TEST UNIT	Code 225-2 (AC-2)
PLANE	xy	FREQ/HZ	30
DEPTH	9.2M	DATE	6/17/82
SEPARATION	1M	TST ENGR	RAD

Figure 8

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



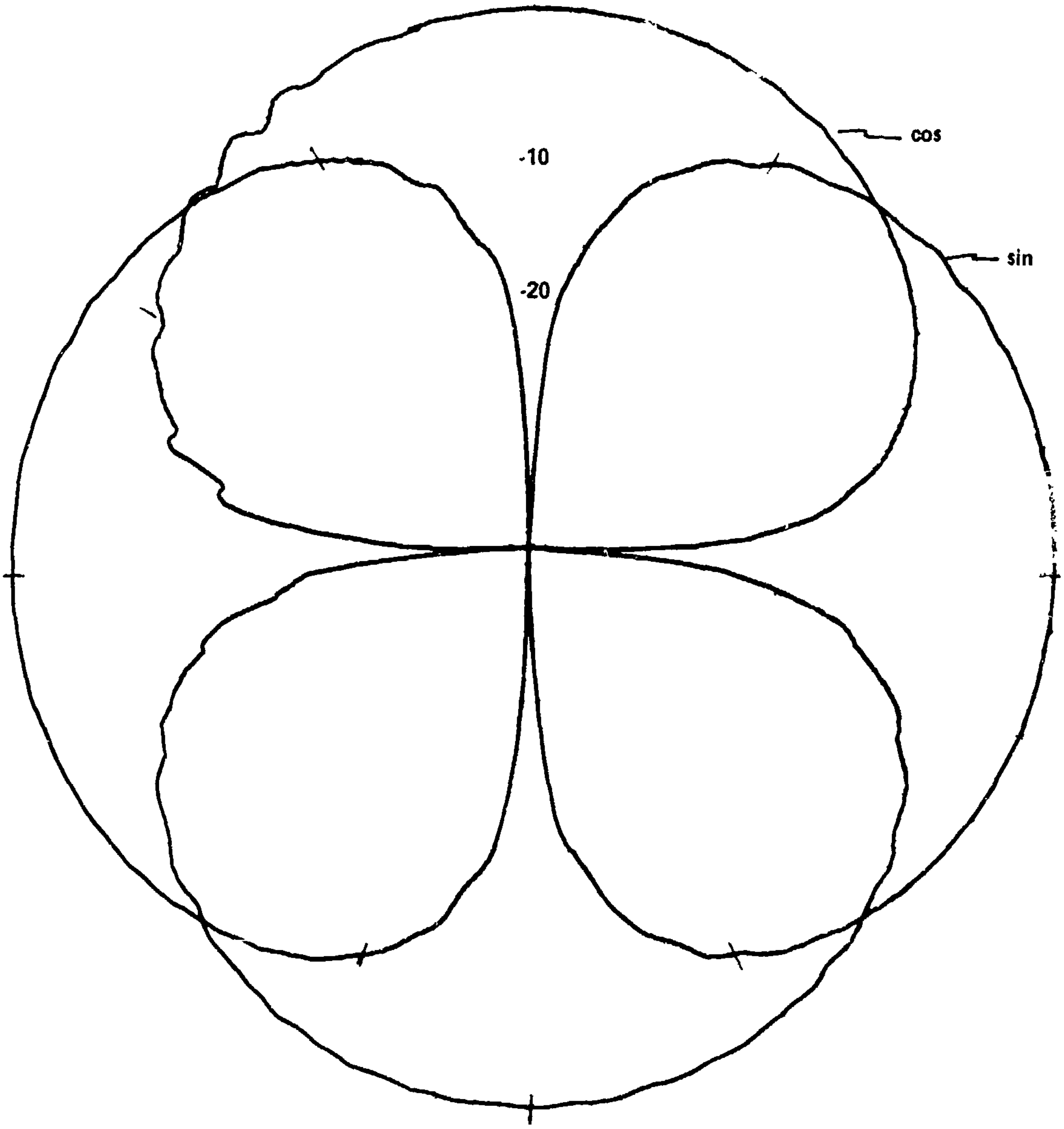
MODE	cw	TEST UNIT	Code 225-2 (AC-2)
PLANE	xy	FREQ/HZ	34
DEPTH	9.2M	DATE	7/15/82
SEPARATION	1M	TST ENGR	RAD

Figure 9

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

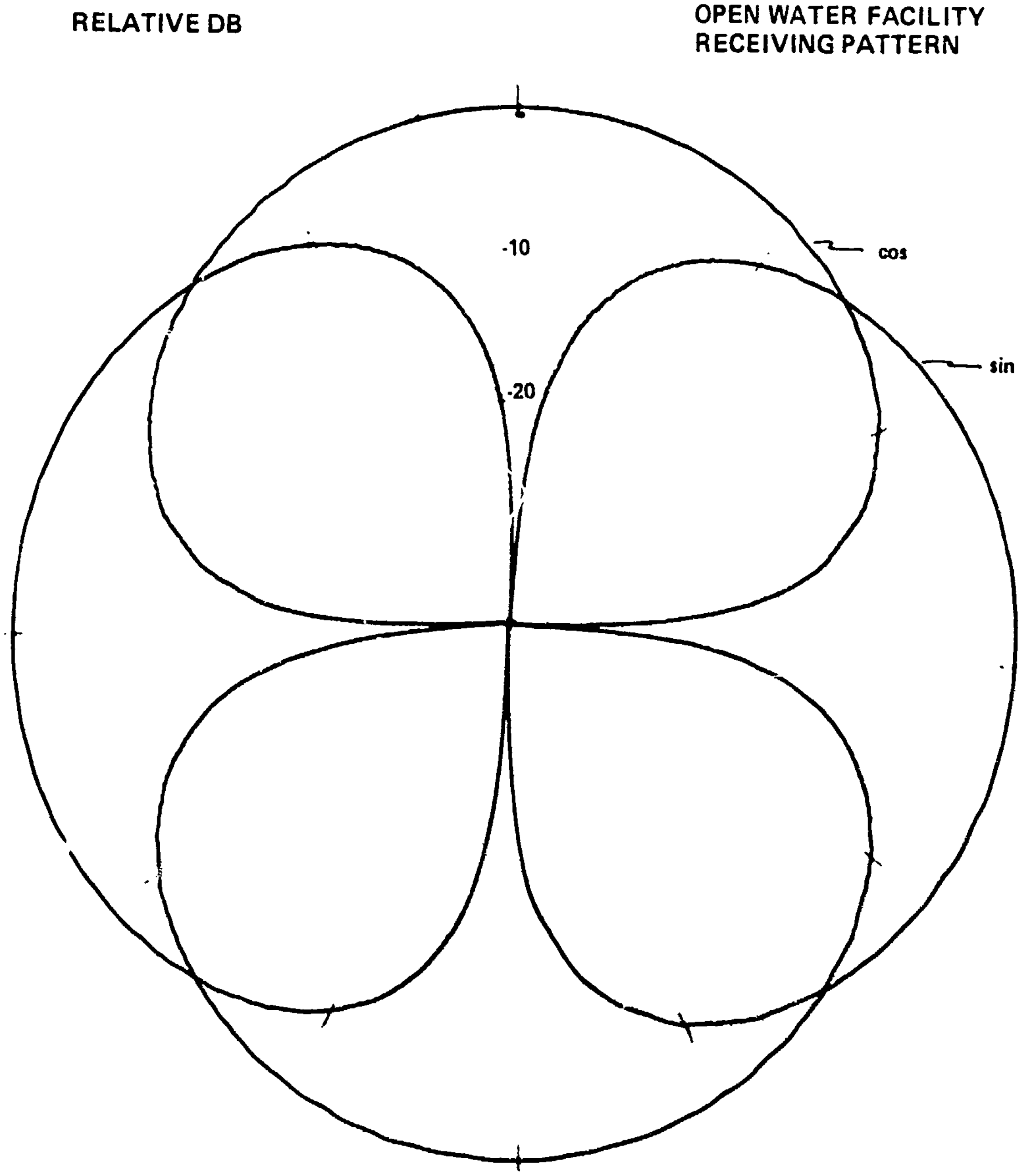
OPEN WATER FACILITY
RECEIVING PATTERN



MODE	cw	TEST UNIT	Code 225-2 (AC-2)
PLANE	xy	FREQ/HZ	50
DEPTH	9.2M	DATE	6/17/82
SEPARATION	1M	TST ENGR	RAD

Figure 10

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES



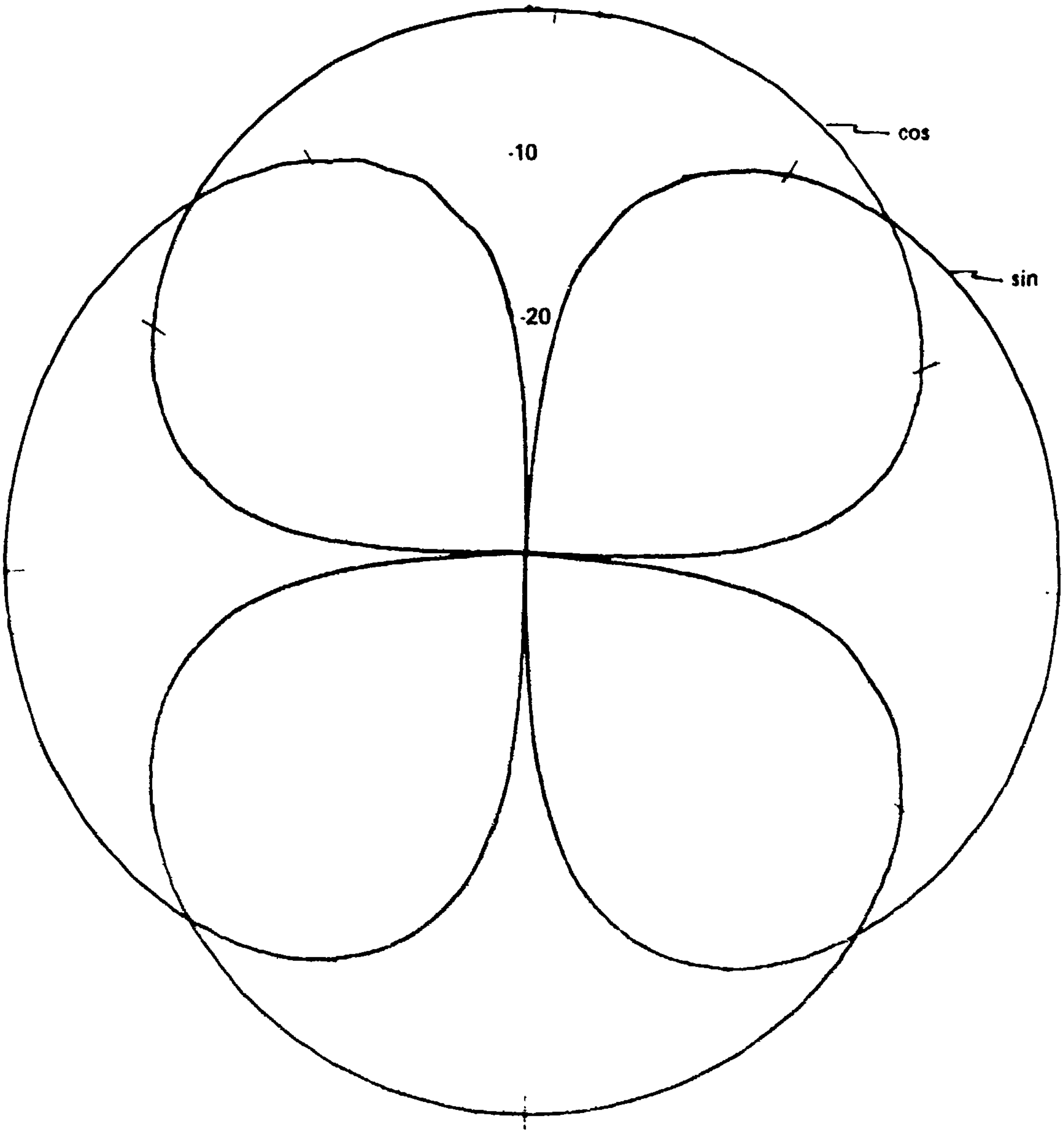
MODE	cw	TEST UNIT	Code 225-2 (AC-2)
PLANE	xy	FREQ/HZ	100
DEPTH	9.2M	DATE	6/17/82
SEPARATION	1M	TST ENGR	RAD

Figure 11

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



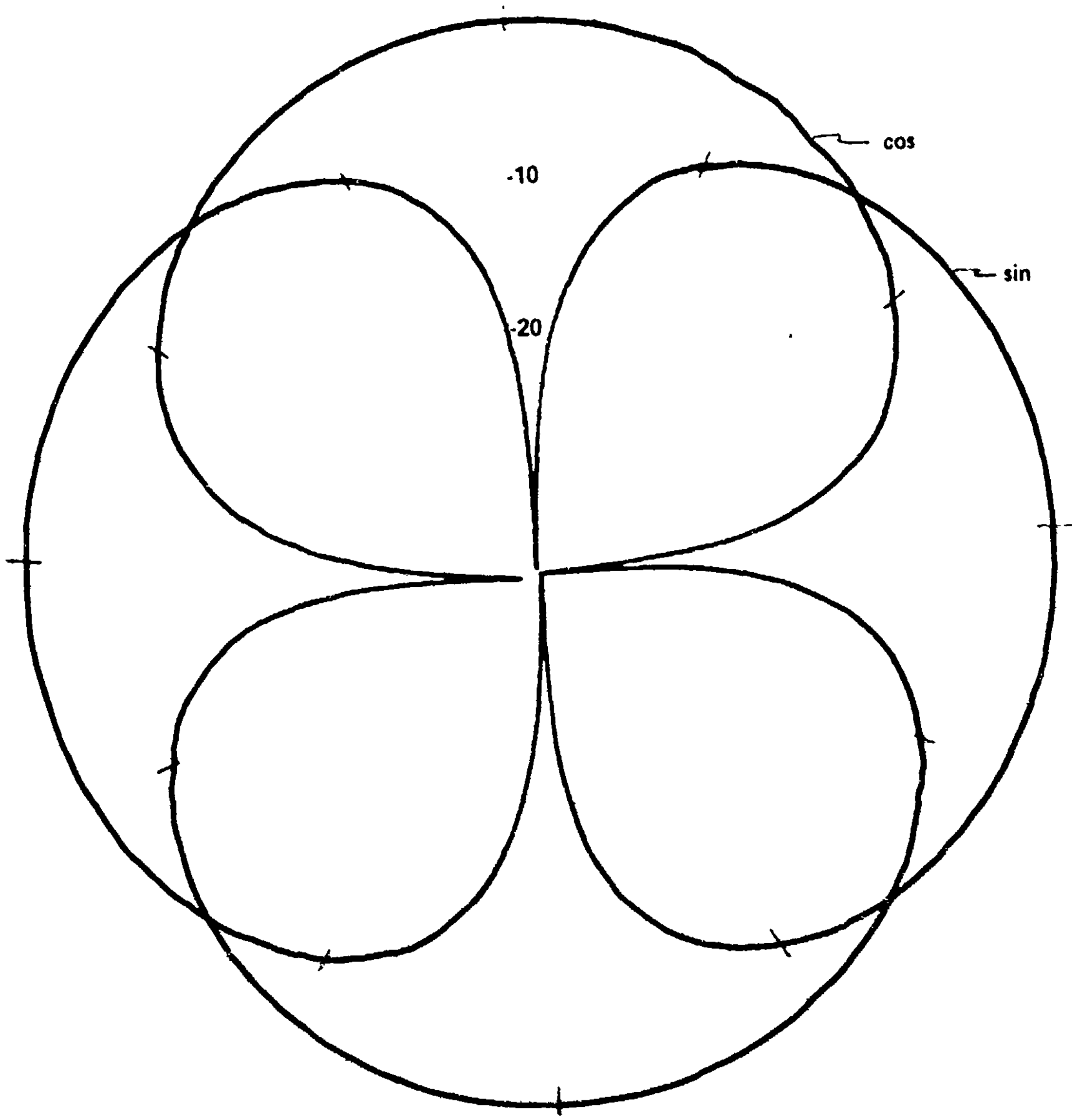
MODE	cw	TEST UNIT	Code 225-2 (AC-2)
PLANE	xy	FREQ/HZ	135
DEPTH	9.2M	DATE	7/15/82
SEPARATION	1M	TST ENGR	RAD

Figure 12

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



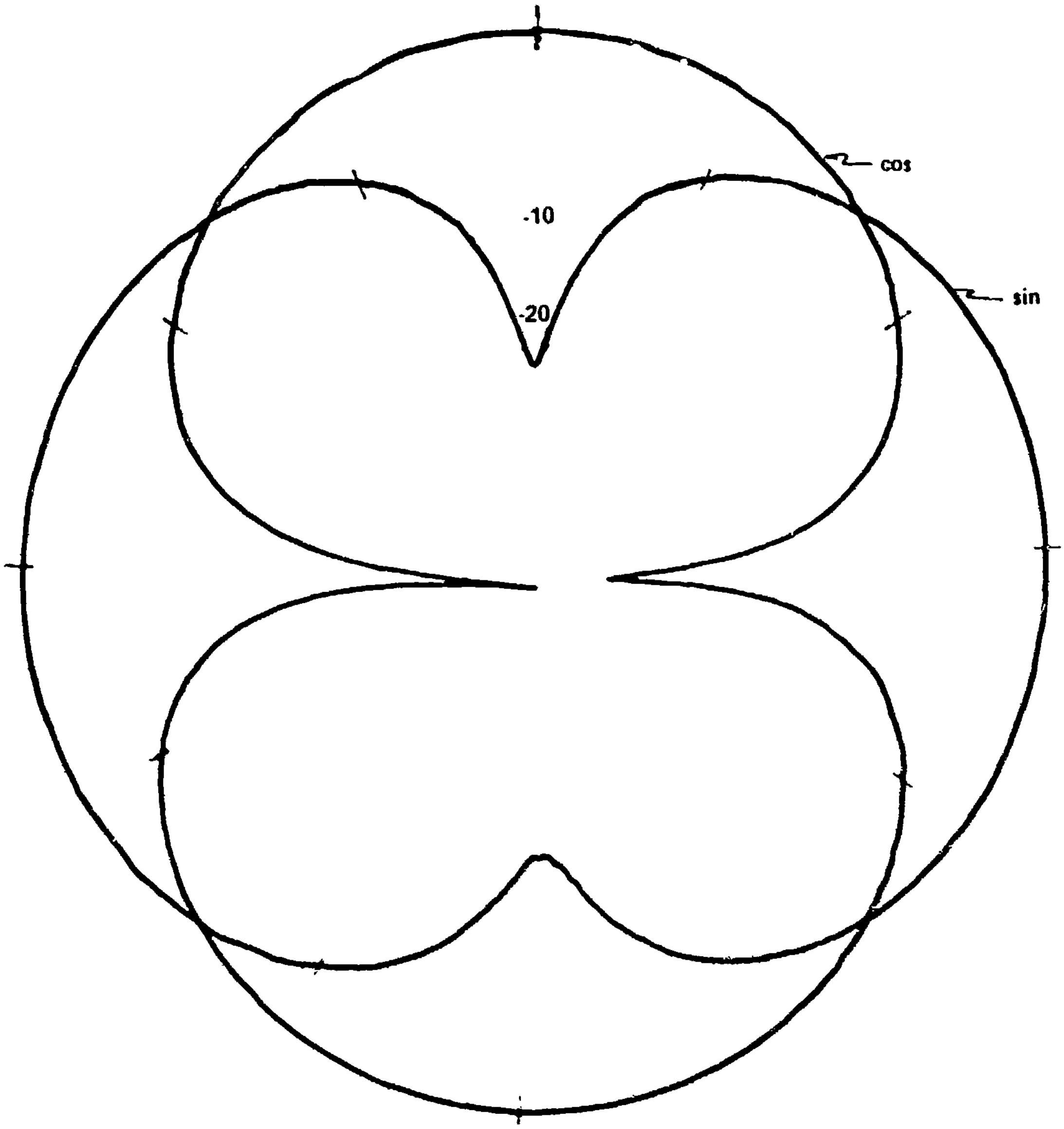
MODE	cw	TEST UNIT	Code 225-2 (AC-2)
PLANE	xy	FREQ/HZ	150
DEPTH	9.2M	DATE	7/15/82
SEPARATION	1M	TST ENGR	RAD

Figure 13

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



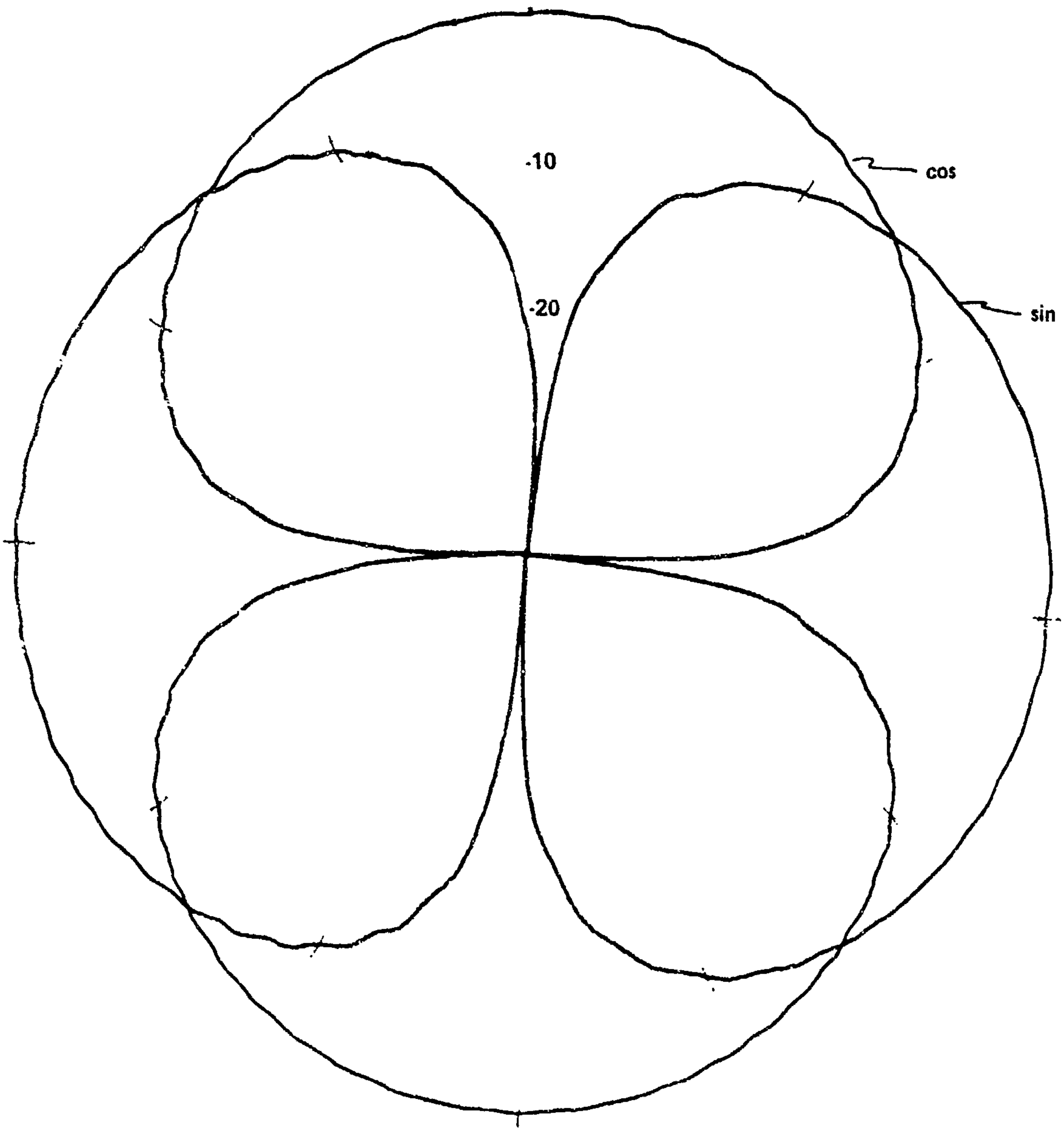
MODE	cw	TEST UNIT	Code 225-2 (AC-2)
PLANE	xy	FREQ/HZ	170
DEPTH	9.2M	DATE	7/15/82
SEPARATION	1M	TST ENGR	RAD

Figure 14

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



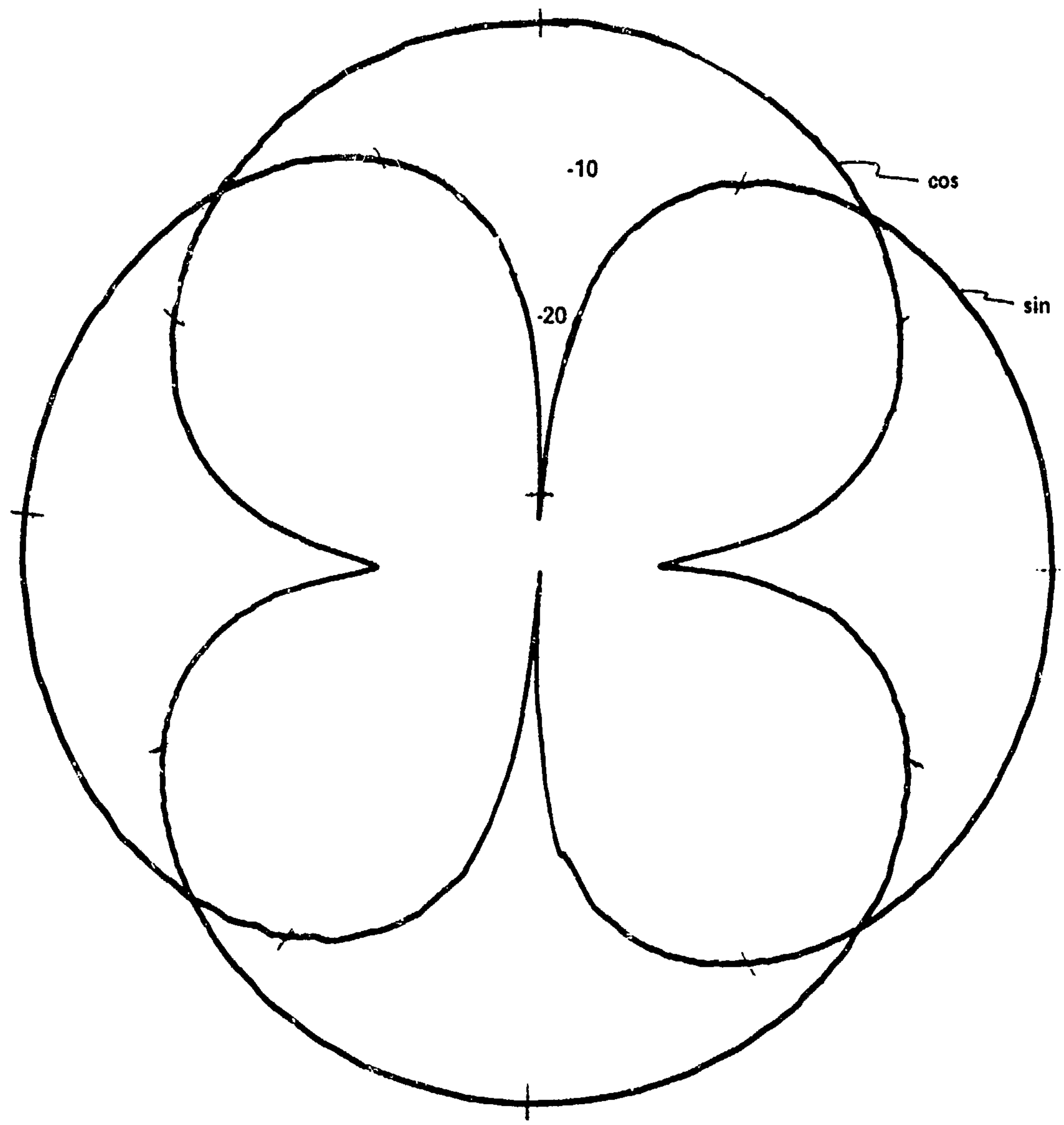
MODE	cw	TEST UNIT	225-2 (AC-2)
PLANE	xy	FREQ/HZ	180 Hz
DEPTH	9.2M	DATE	6/17/82
SEPARATION	1M	TST ENGR	RAD

Figure 15

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



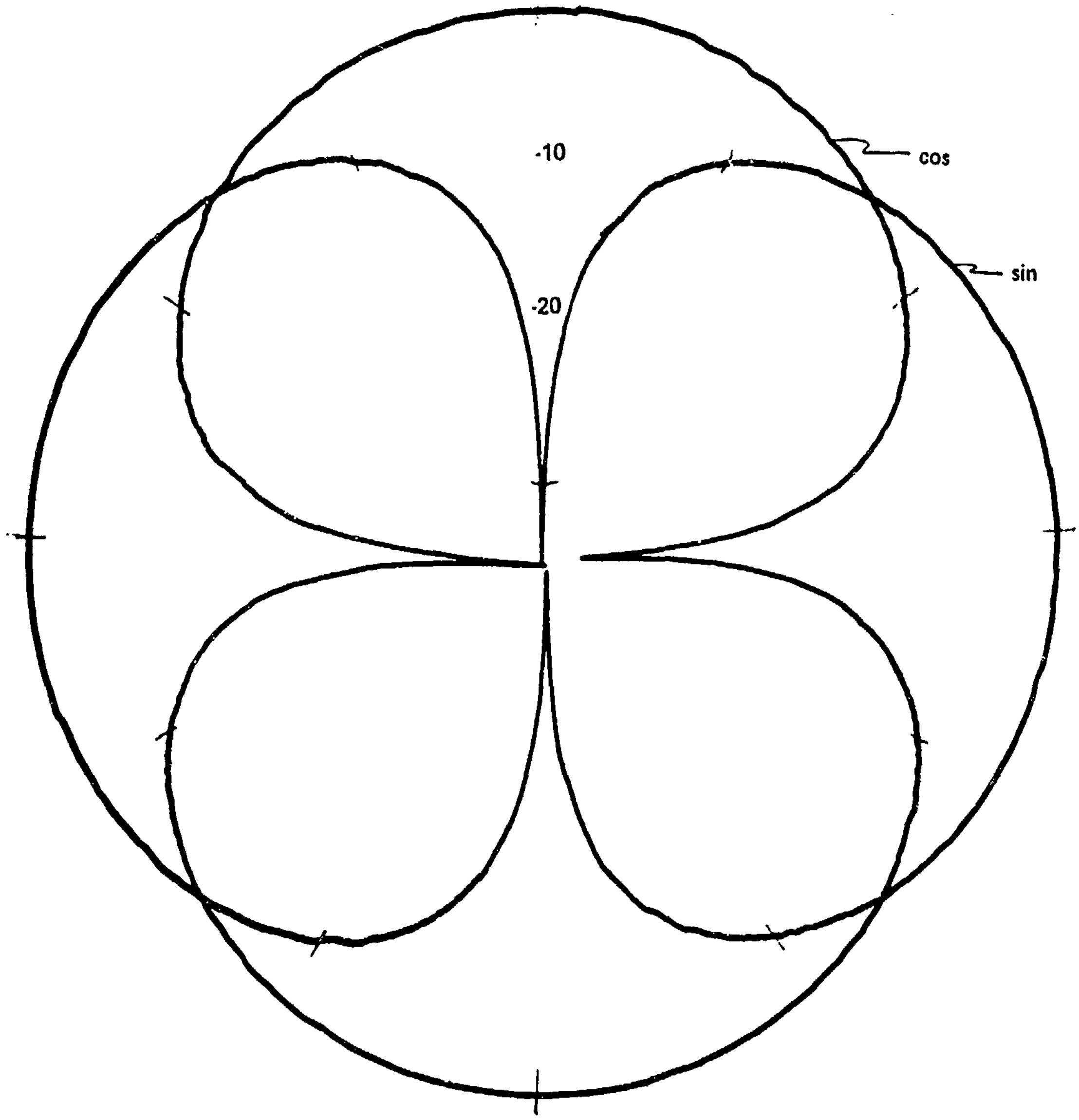
MODE	cw	TEST UNIT	Code 225-2 (AC-2)
PLANE	xy	FREQ/HZ	200
DEPTH	9.2M	DATE	7/15/82
SEPARATION	1M	TST ENGR	RAD

Figure 16

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



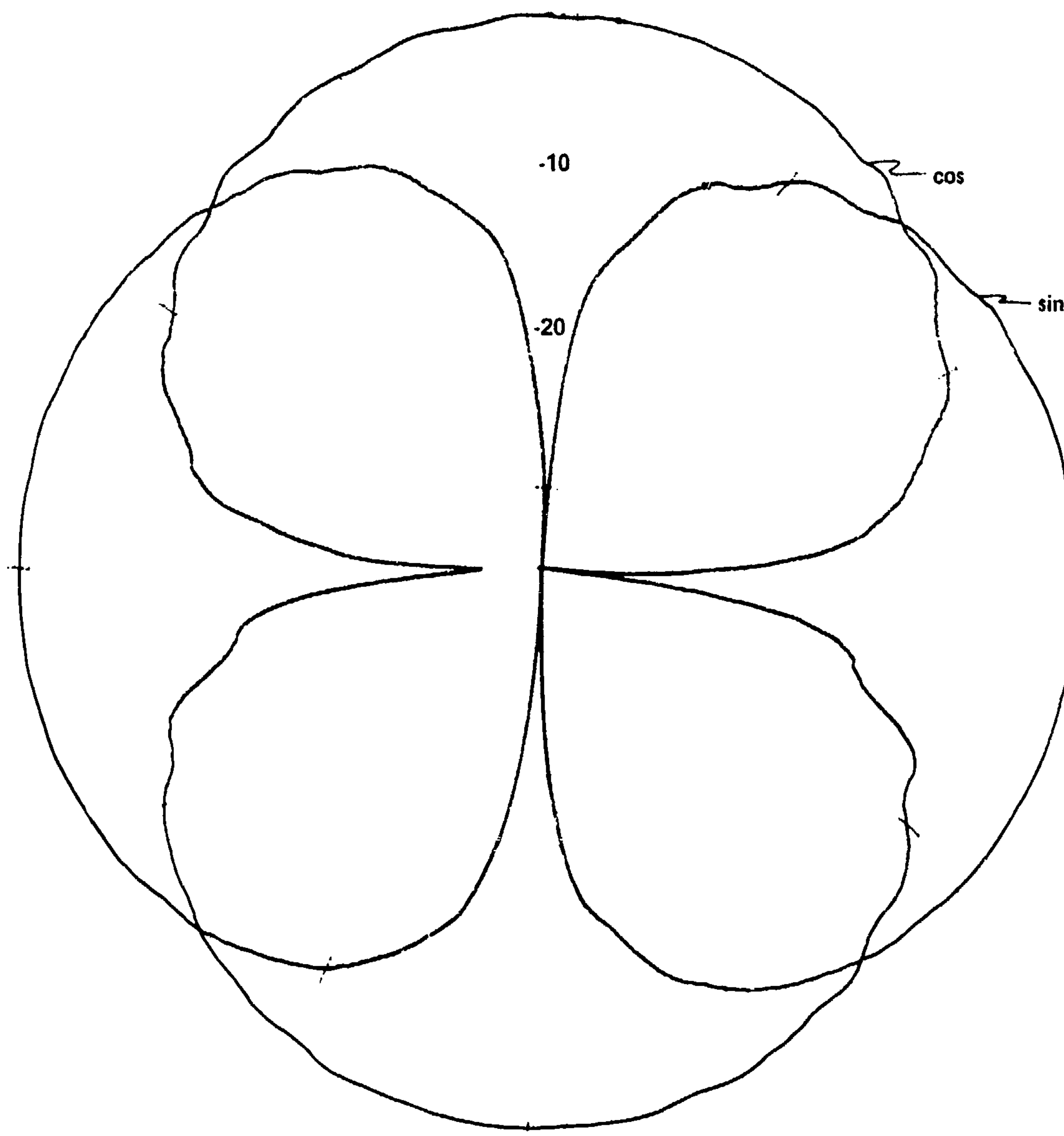
MODE	cw		TEST UNIT	Code 225-2 (AC-2)
PLANE	xy		FREQ/HZ	250
DEPTH	9.2M		DATE	7/15/82
SEPARATION	1M		TST ENGR	RAD

Figure 17

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



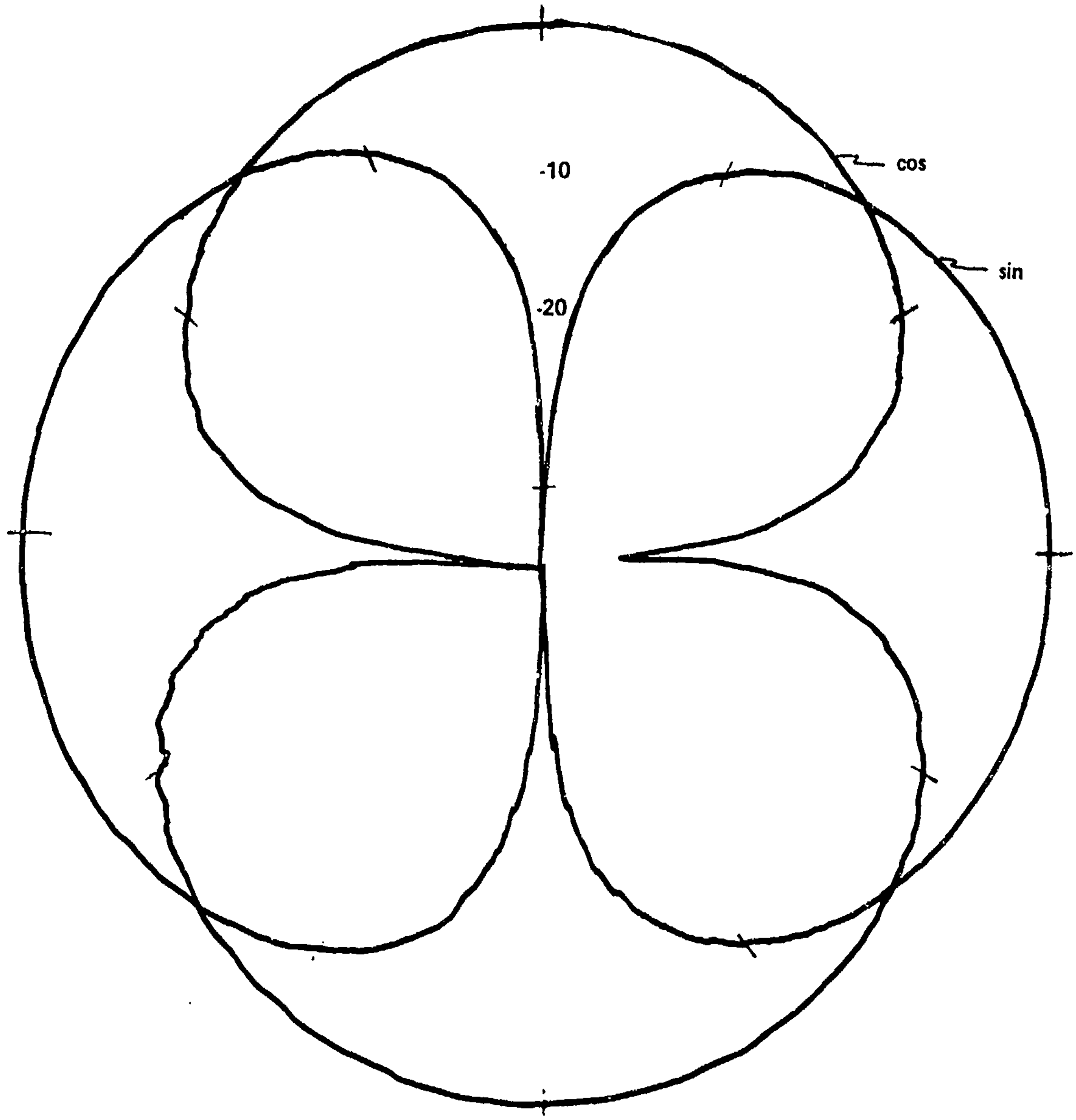
MODE	cw	TEST UNIT	Code 225-2 (AC-2)
PLANE	xy	FREQ/HZ	500
DEPTH	9.2M	DATE	6/17/82
SEPARATION	1M	TST ENGR	RAD

Figure 18

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



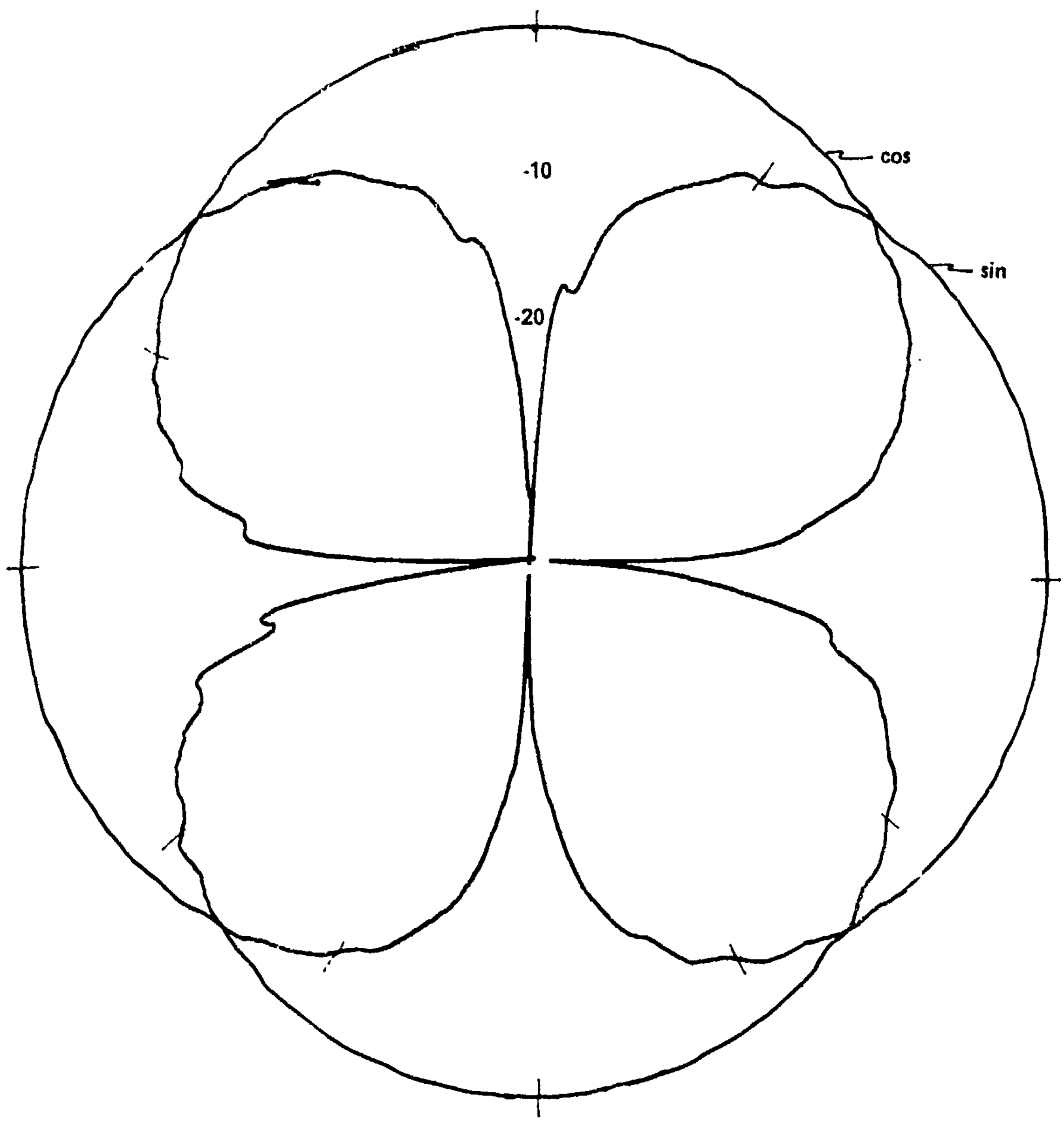
MODE	cw	TEST UNIT	Code 225-2 (AC-2)
PLANE	xy	FREQ/HZ	750
DEPTH	9.2M	DATE	7/15/82
SEPARATION	1M	TST ENGR	RAD

Figure 19

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



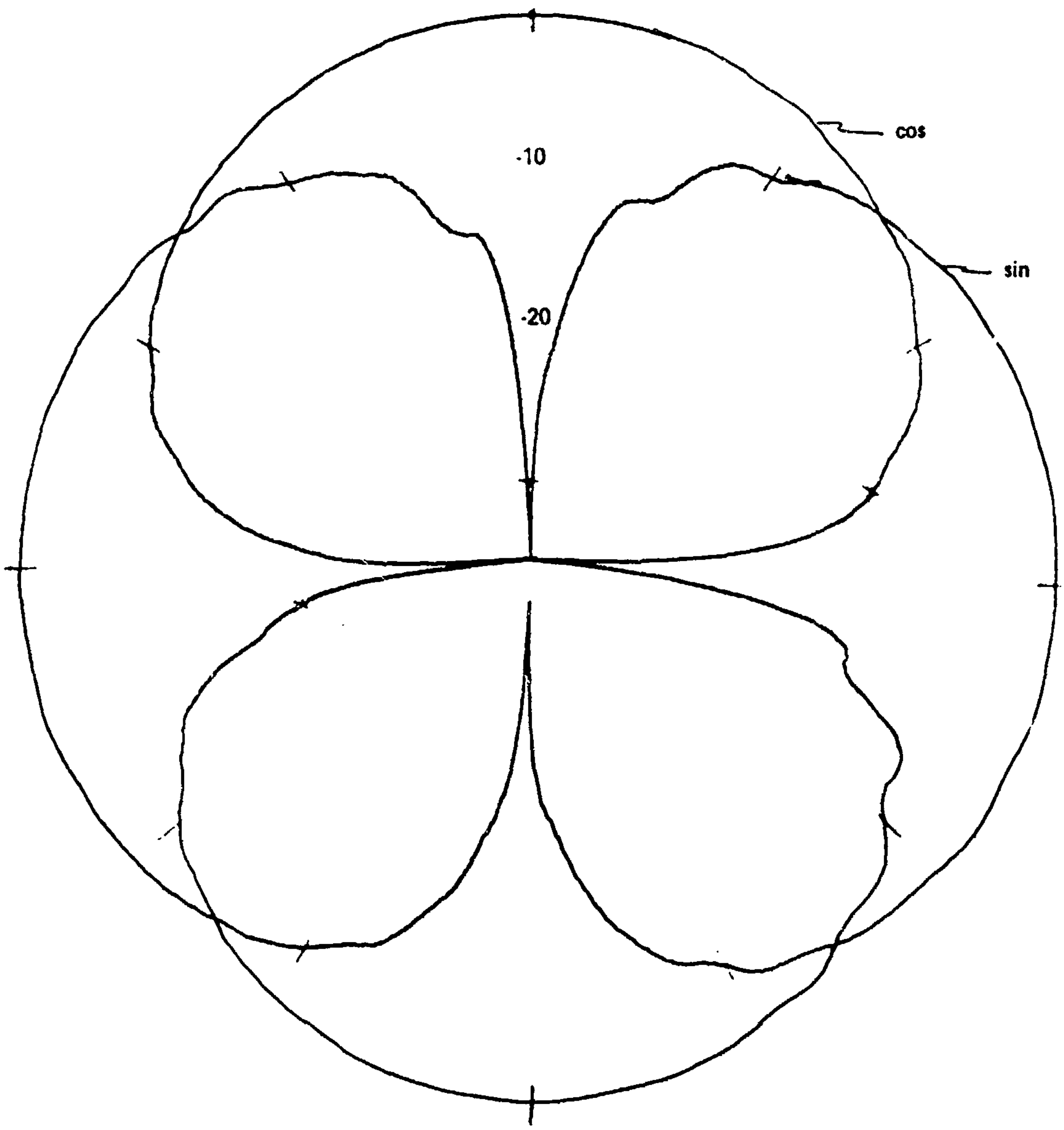
MODE	cw	TEST UNIT	Code 225-2 (AC-2)
PLANE	xy	FREQ/HZ	1000
DEPTH	9.2M	DATE	6/17/82
SEPARATION	1M	TST ENGR	RAD

Figure 20

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

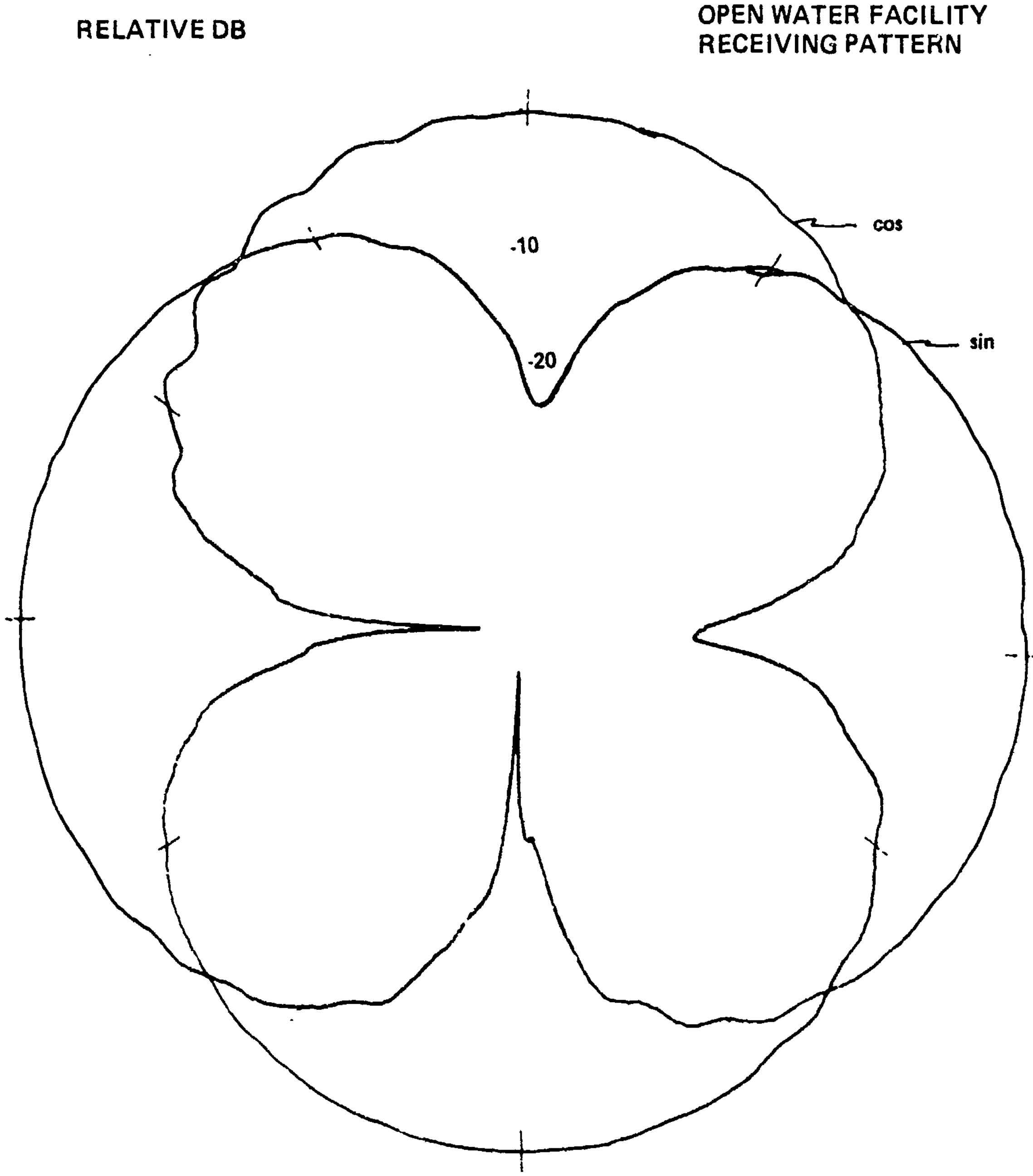
OPEN WATER FACILITY
RECEIVING PATTERN



MODE	cw	TEST UNIT	Code 225-2 (AC-2)
PLANE	xy	FREQ/HZ	1500
DEPTH	9.2M	DATE	6/17/82
SEPARATION	1M	TST ENGR	RAD

Figure 21

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES



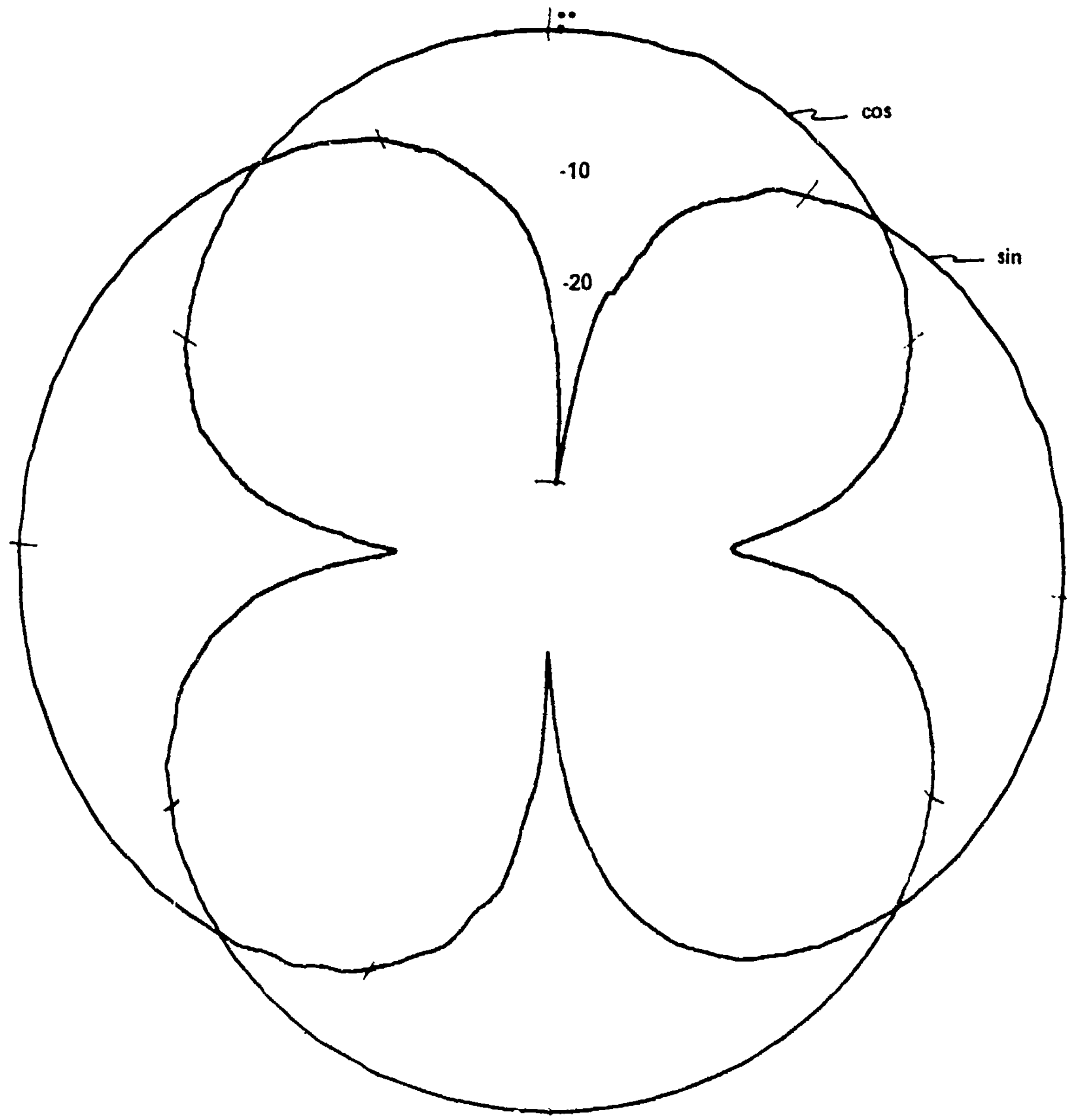
MODE	cw		TEST UNIT	Code 225-2 (AC-2)
PLANE	xy		FREQ/HZ	2000
DEPTH	9.2M		DATE	6/17/82
SEPARATION	1M		TST ENGR	RAD

Figure 22

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



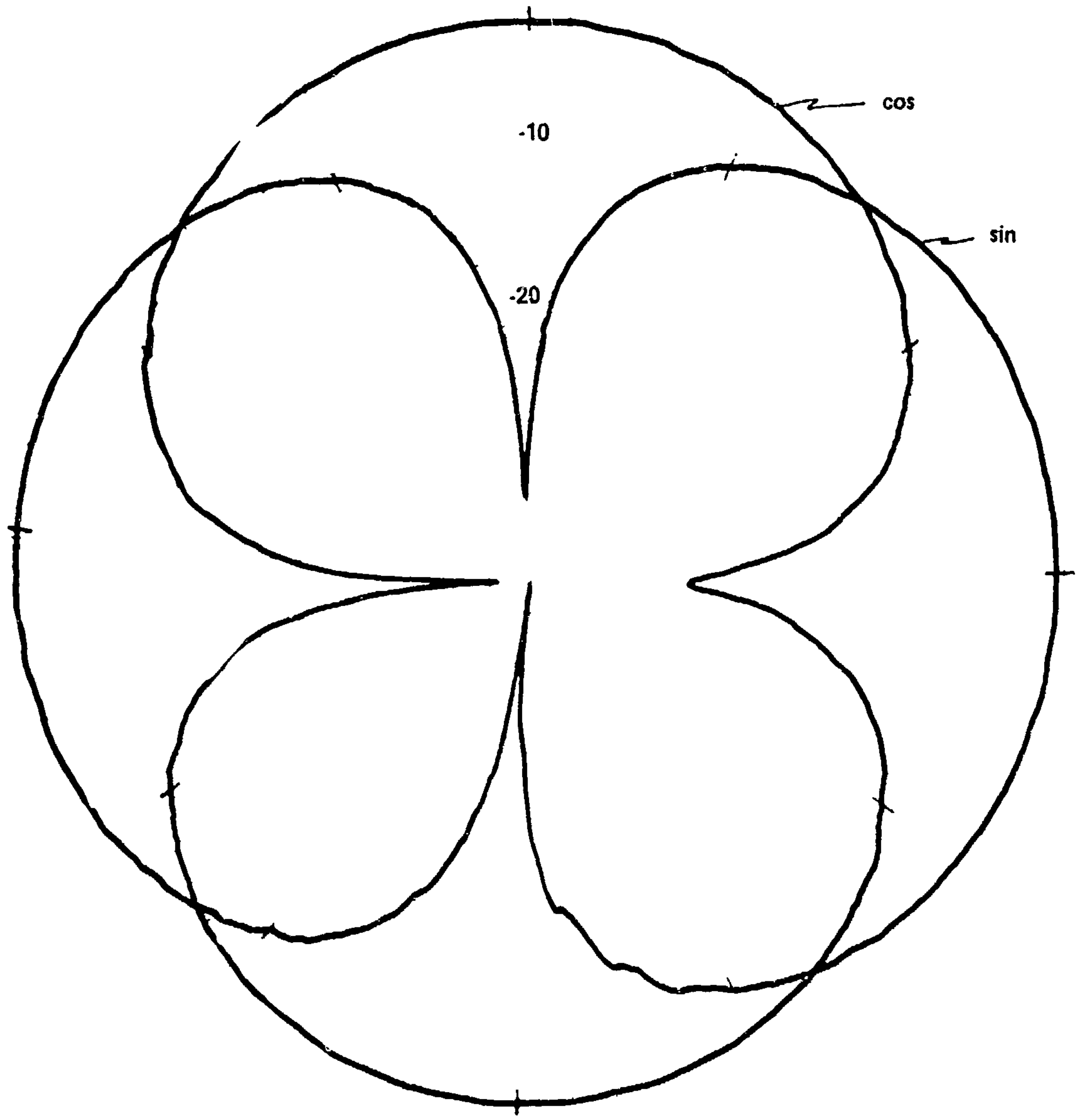
MODE	cw	TEST UNIT	Code 225-2 (AC-2)
PLANE	xy	FREQ/HZ	2300
DEPTH	9.2M	DATE	6/17/82
SEPARATION	1M	TST ENGR	RAD

Figure 23

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



MODE	cw	TEST UNIT	Code 225-2 (AC-2)
PLANE	xy	FREQ/HZ	2500 Hz
DEPTH	9.2M	DATE	7/15/82
SEPARATION	1M	TST ENGR	RAD

Figure 24

APPENDIX A
MEASUREMENT DATA
ON ACODAC 1

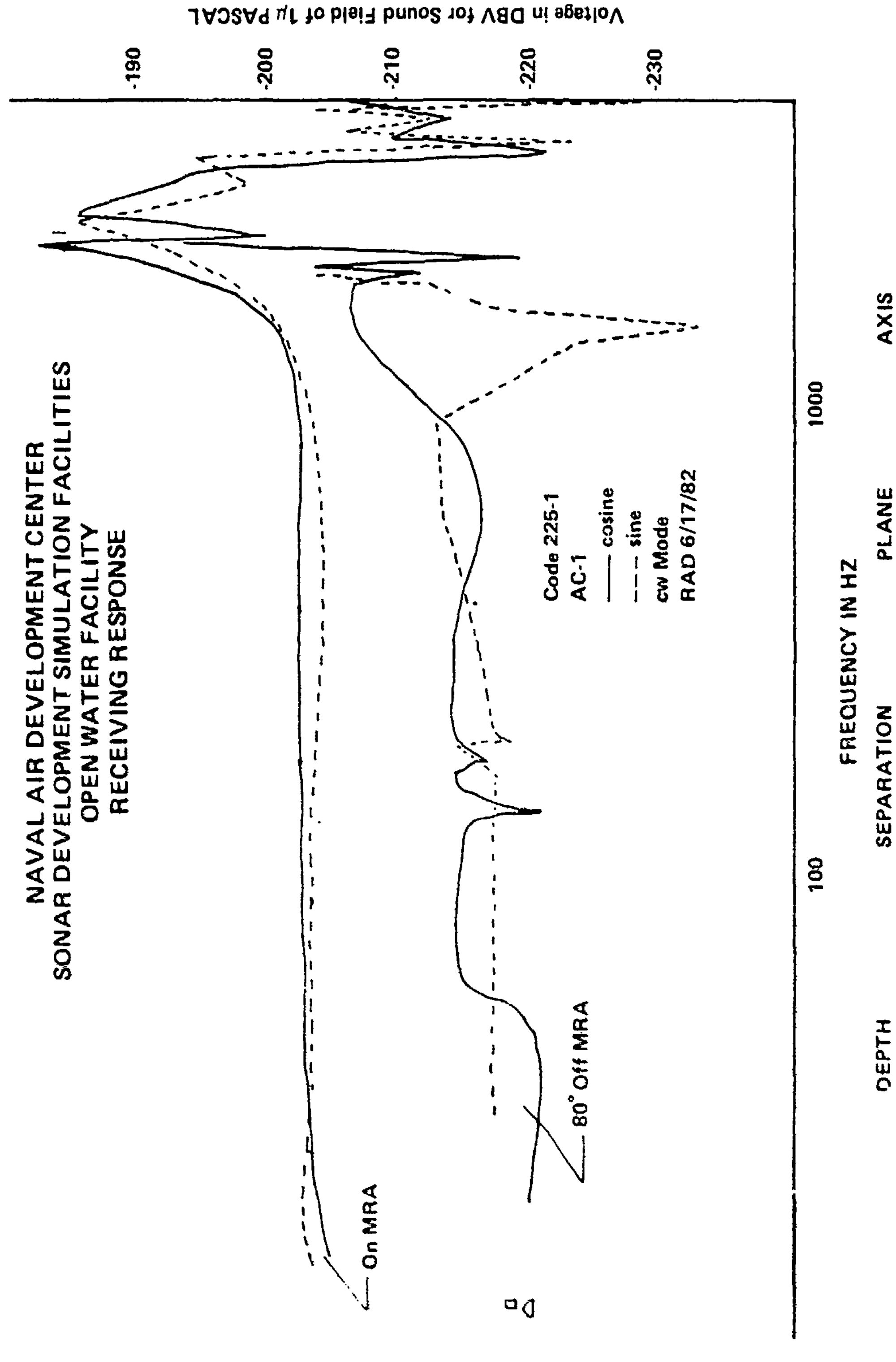

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES
OPEN WATER FACILITY
RECEIVING RESPONSE
Voltage in DBV for Sound Field of 1μ PASCAL
-190
-200
-210
-220
-230
Code 225-1
AC-1
—— cosine
- - - sine
cw Mode
RAD 6/17/82
On MRA
80° Off MRA
100
1000
FREQUENCY IN HZ
DEPTH SEPARATION PLANE AXIS

Figure A-1

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES
OPEN WATER FACILITY

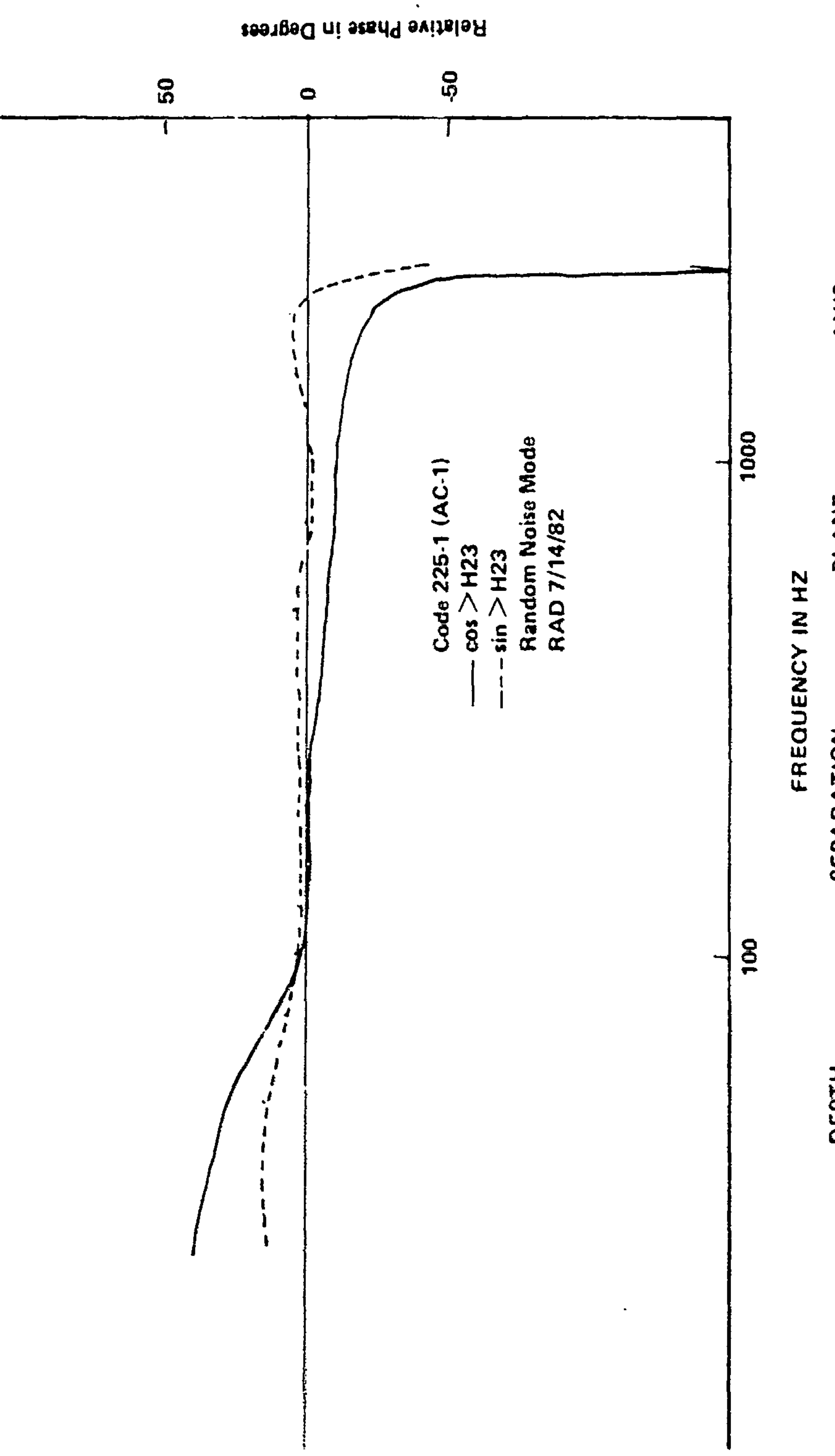


Figure A-2

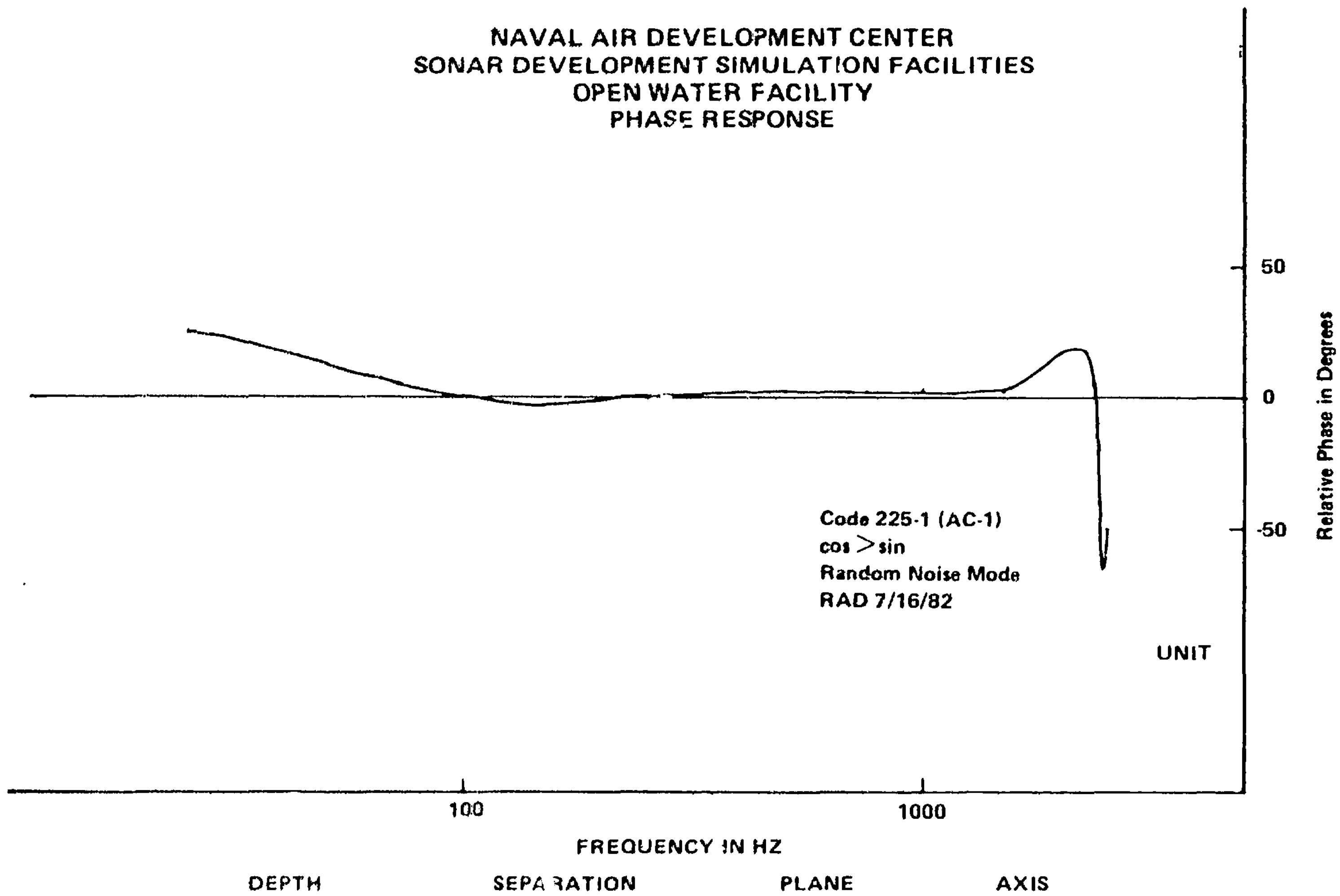
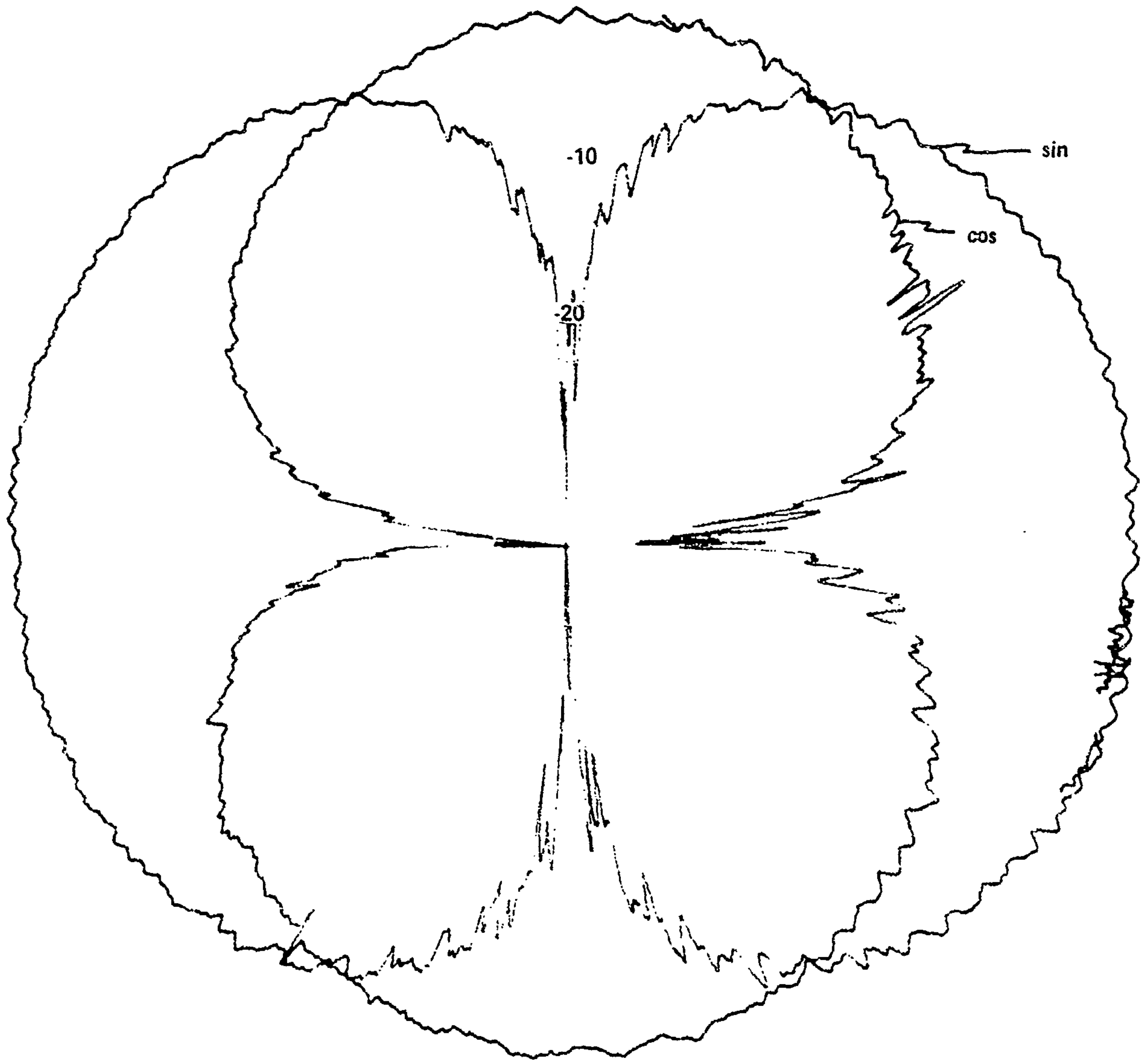

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES
OPEN WATER FACILITY
PHASE RESPONSE
50
0
-50
Relative Phase in Degrees
Code 225-1 (AC-1)
cos > sin
Random Noise Mode
RAD 7/16/82
UNIT
100
1000
FREQUENCY IN HZ
DEPTH
SEPARATION
PLANE
AXIS

Figure A-3

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



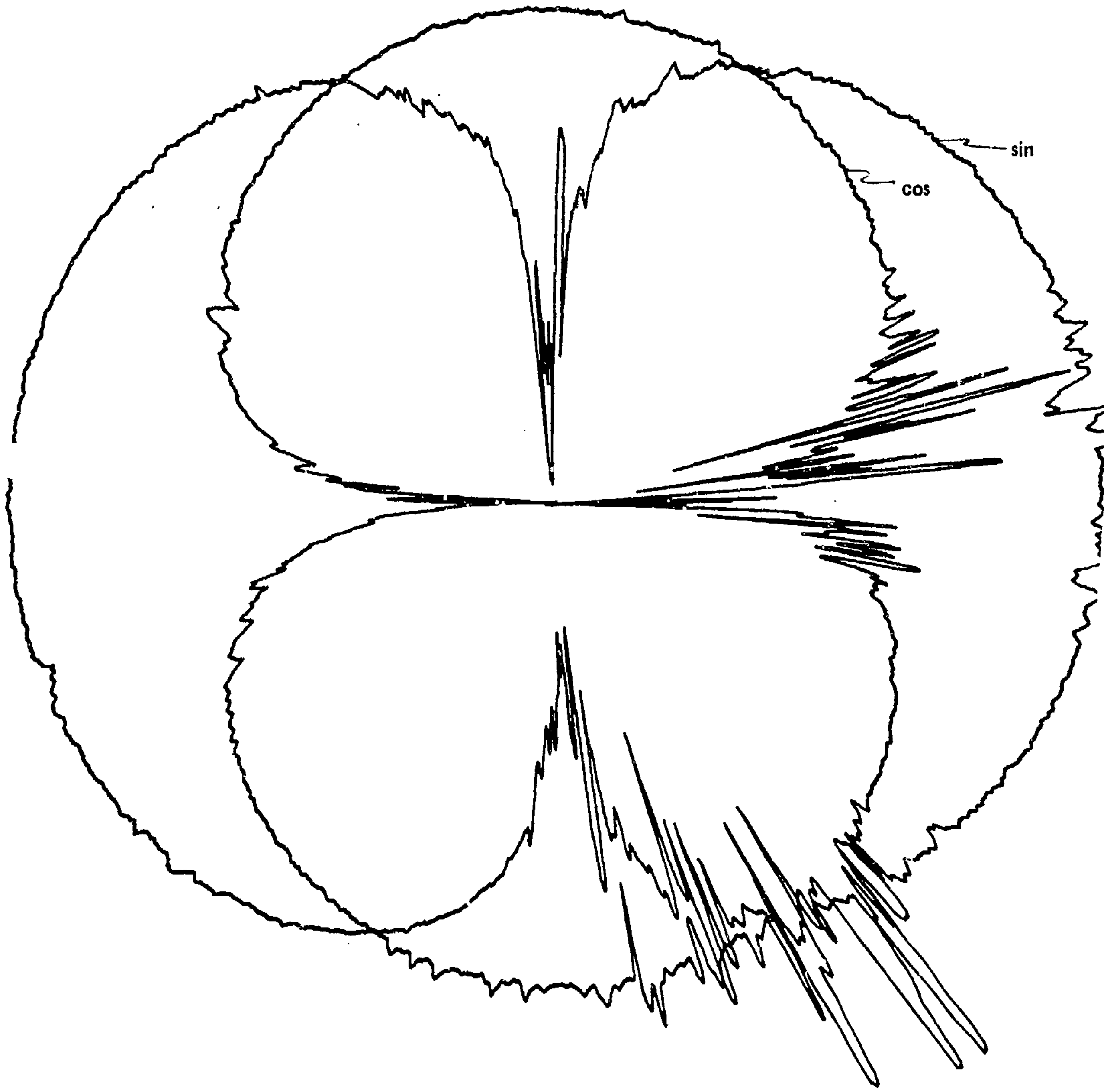
MODE	cw	TEST UNIT	Code 225-1 (AC-1)
PLANE	xy	FREQ/HZ	10
DEPTH	9.2M	DATE	6/22/82
SEPARATION	1M	TST ENGR	RAD

Figure A-4

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



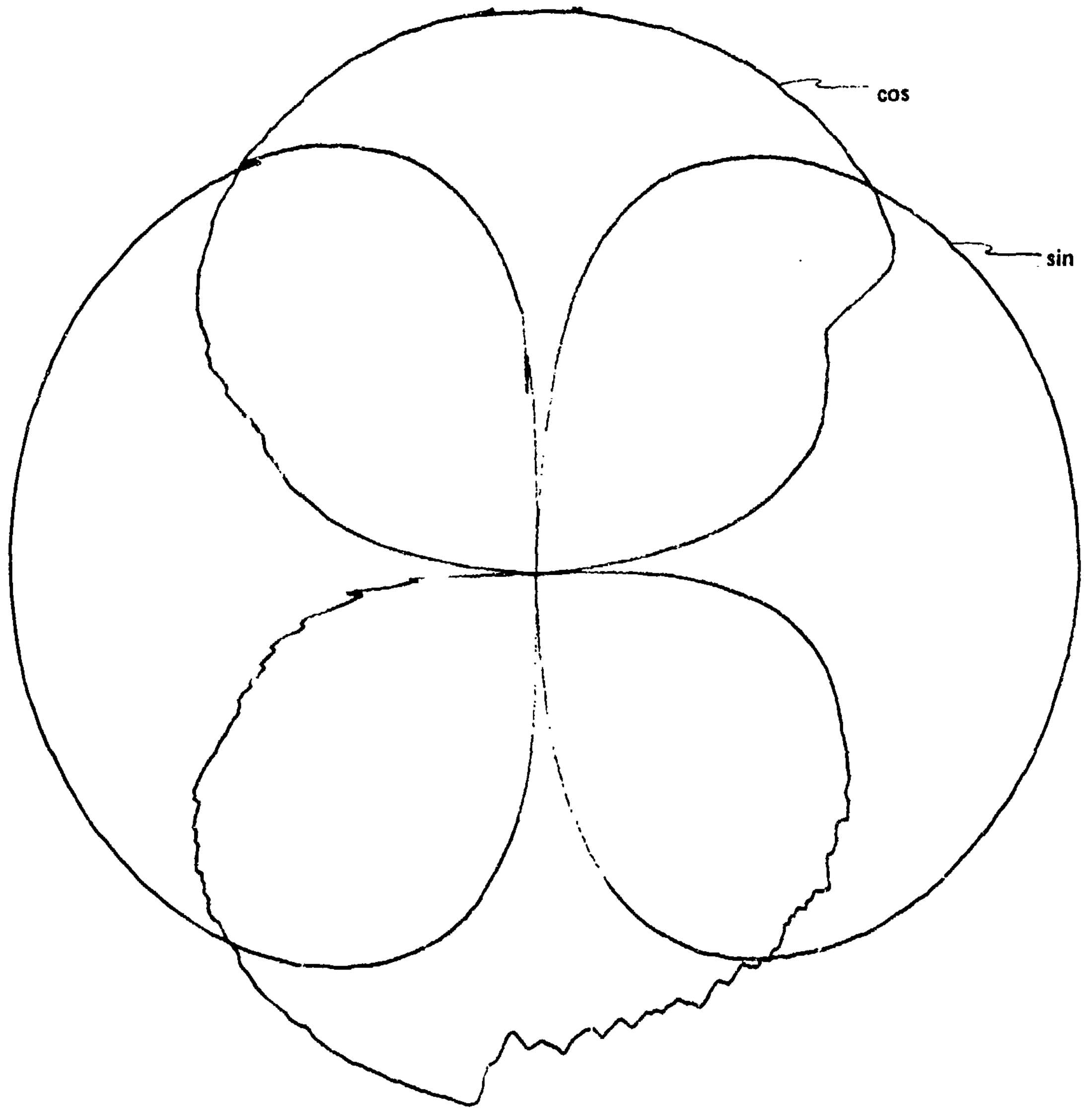
MODE	cw	TEST UNIT	Code 225-1 (AC-1)
PLANE	xy	FREQ/HZ	10
DEPTH	9.2M	DATE	6/22/82
SEPARATION	2M	TST ENGR	RAD

Figure A-5

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



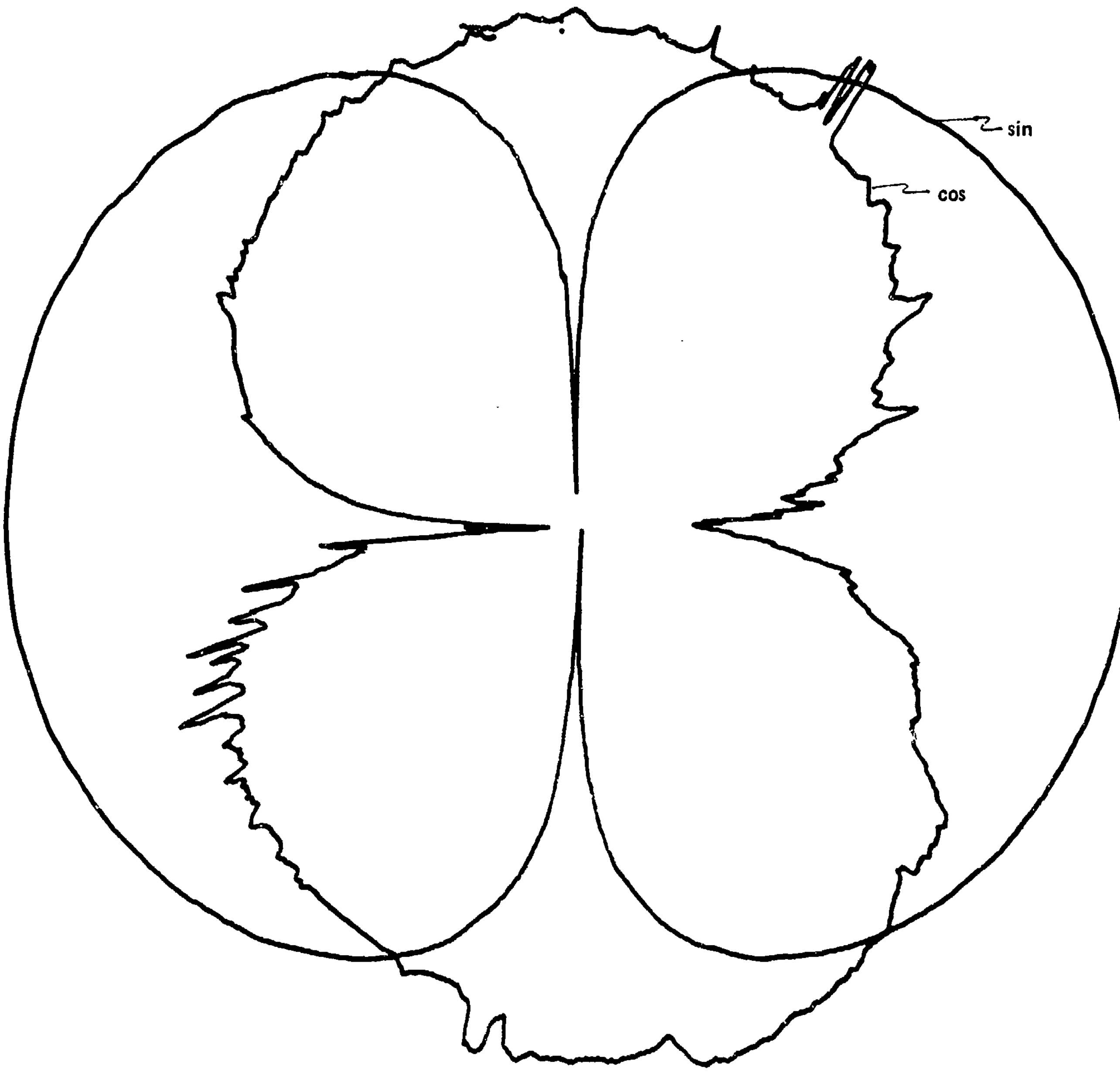
MODE	cw	TEST UNIT	Code 225-1 (AC-1)
PLANE	xy	FREQ/HZ	30
DEPTH	9.2M	DATE	6/22/82
SEPARATION	1M	TST ENGR	RAD

Figure A-6

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



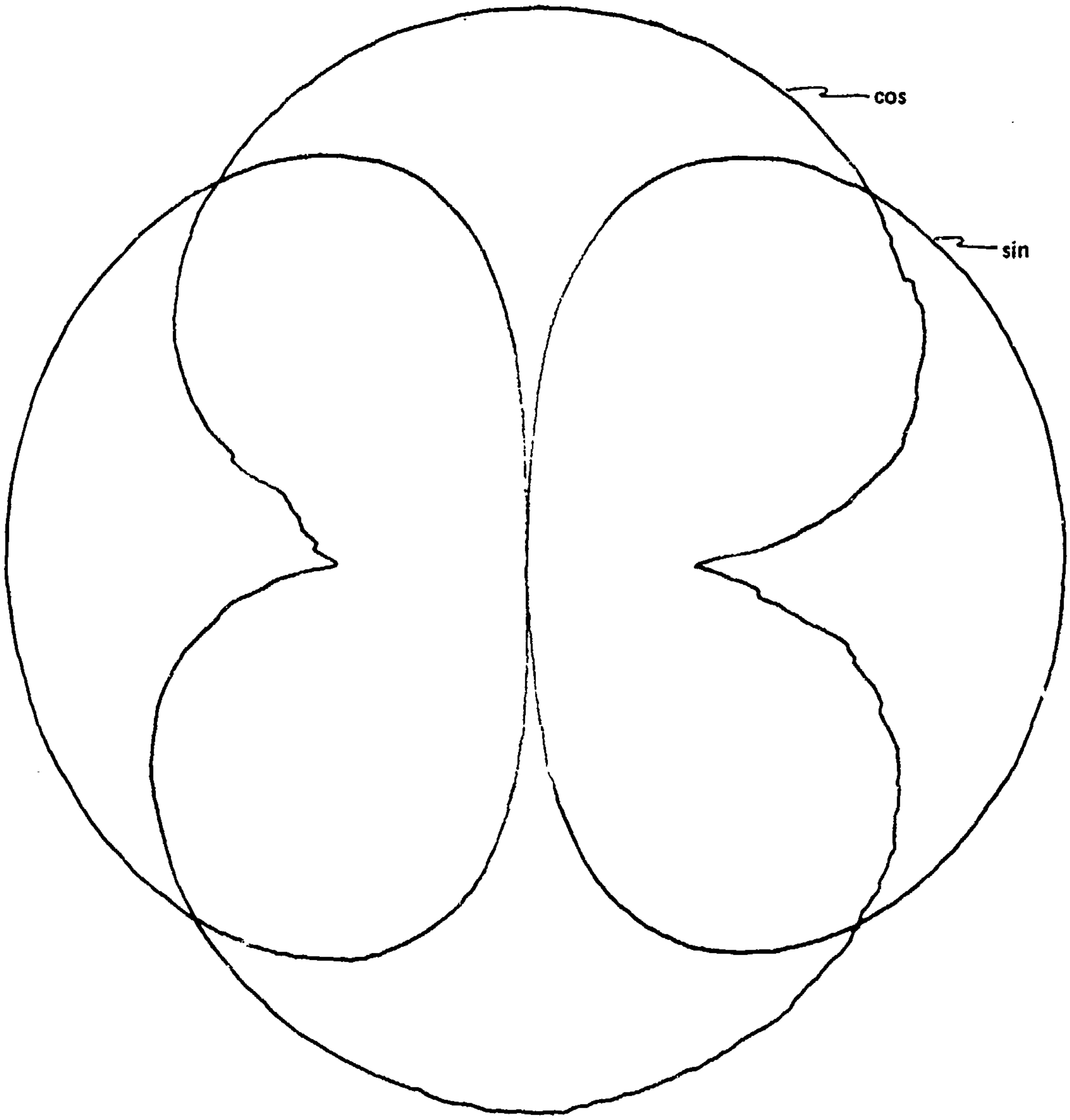
MODE	cw	TEST UNIT	Code 225-1 (AC-1)
PLANE	xy	FREQ/HZ	30
DEPTH	9.2M	DATE	7/13/82
SEPARATION	1M	TST ENGR	RAD

Figure A-7

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



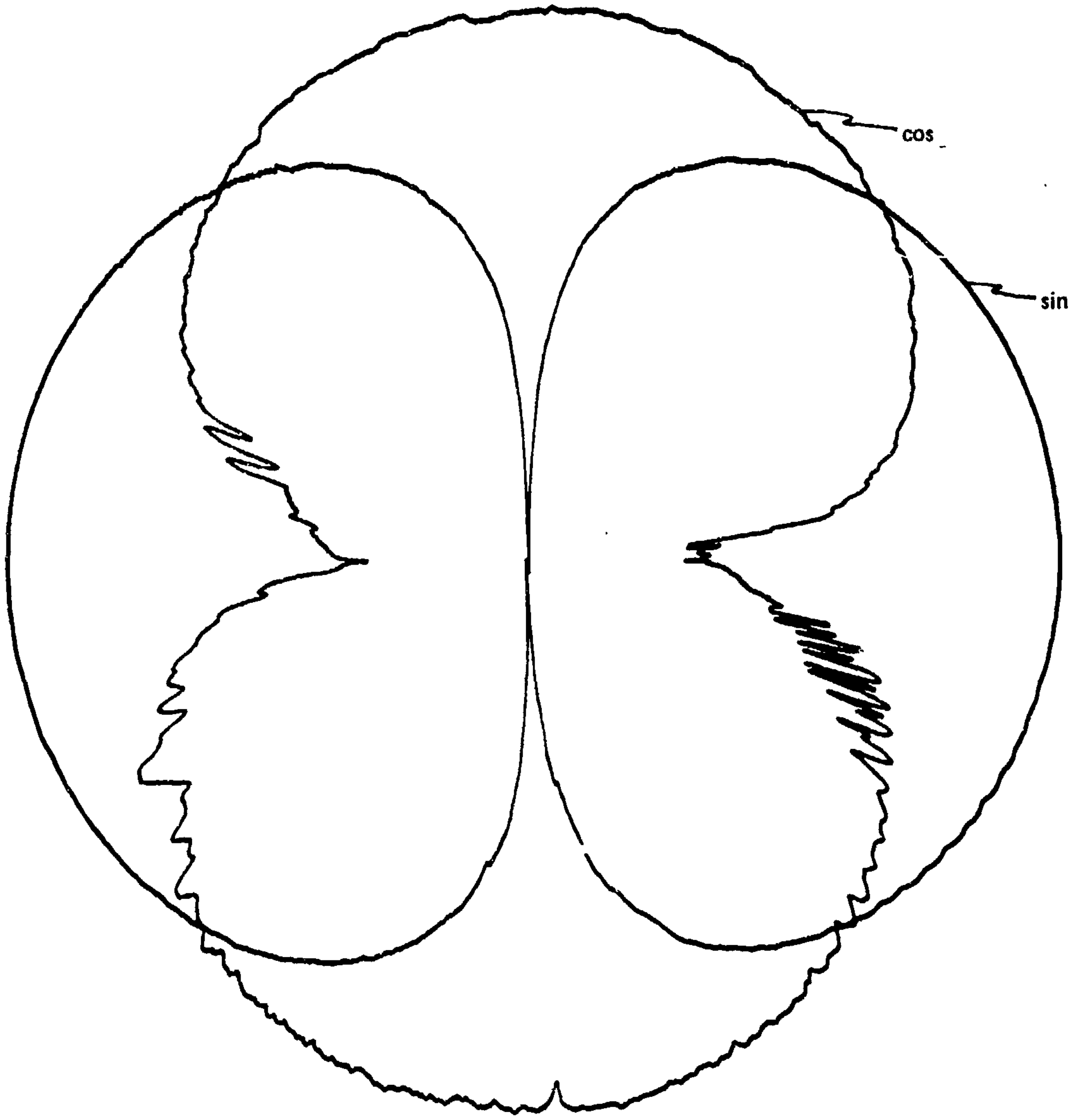
MODE	cw	TEST UNIT	Code 225-1 (AC-1)
PLANE	xy	FREQ/HZ	50
DEPTH	9.2M	DATE	6/22/82
SEPARATION	1M	TST ENGR	RAD

Figure A-8

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



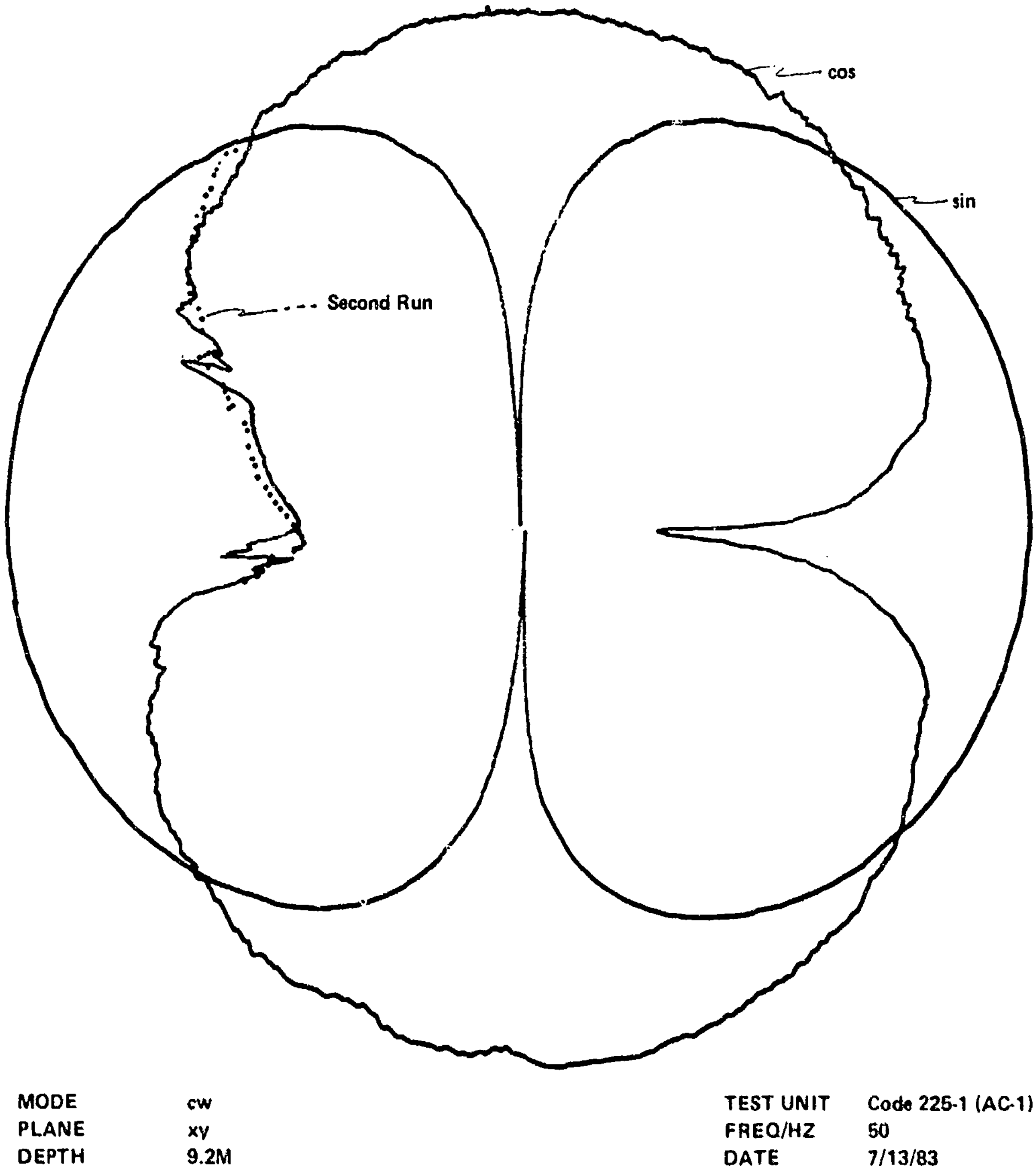
MODE	cw	TEST UNIT	Code 225-1 (AC-1)
PLANE	xy	FREQ/HZ	50
DEPTH	9.2M	DATE	6/22/82
SEPARATION	2M	TEST ENGR	RAD

Figure A-9

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



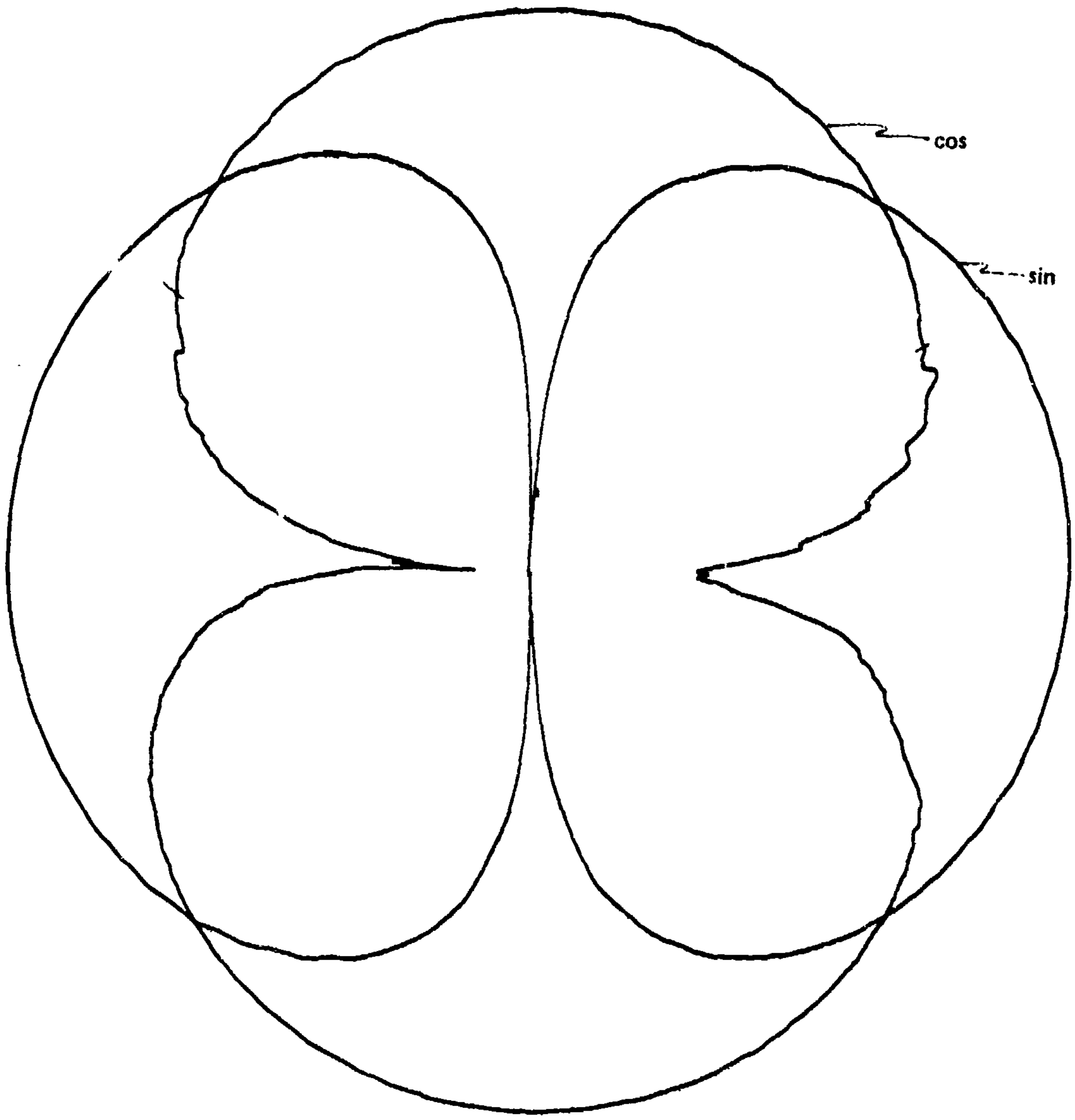
MODE	cw	TEST UNIT	Code 225-1 (AC-1)
PLANE	xy	FREQ/HZ	50
DEPTH	9.2M	DATE	7/13/83
SEPARATION	1M	TST ENGR	RAD

Figure A-10

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



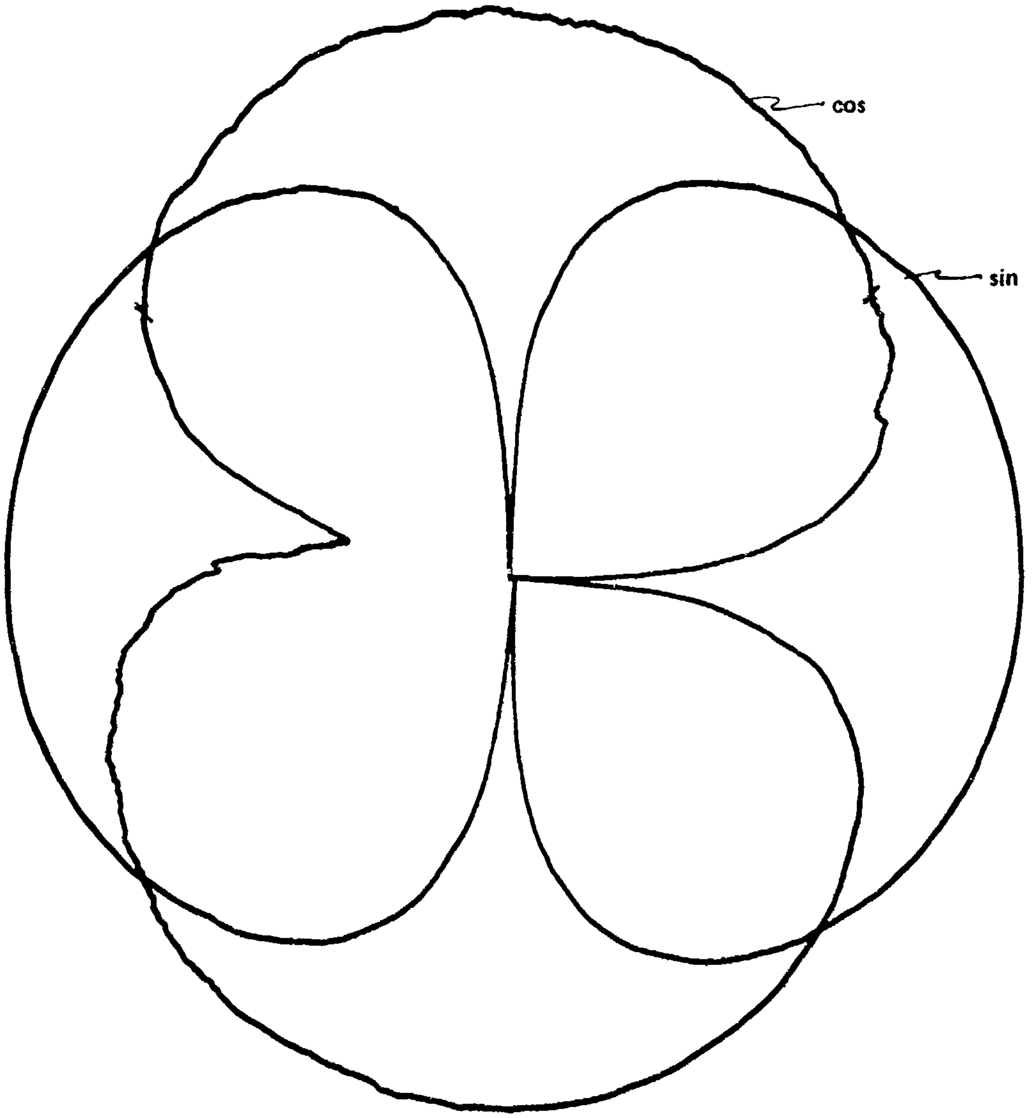
MODE	cw	TEST UNIT	Code-225-1 (AC-1)
PLANE	xy	FREQ/HZ	100
DEPTH	9.2M	DATE	6/22/82
SEPARATION	1M	TST ENGR	RAD

Figure A-11

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



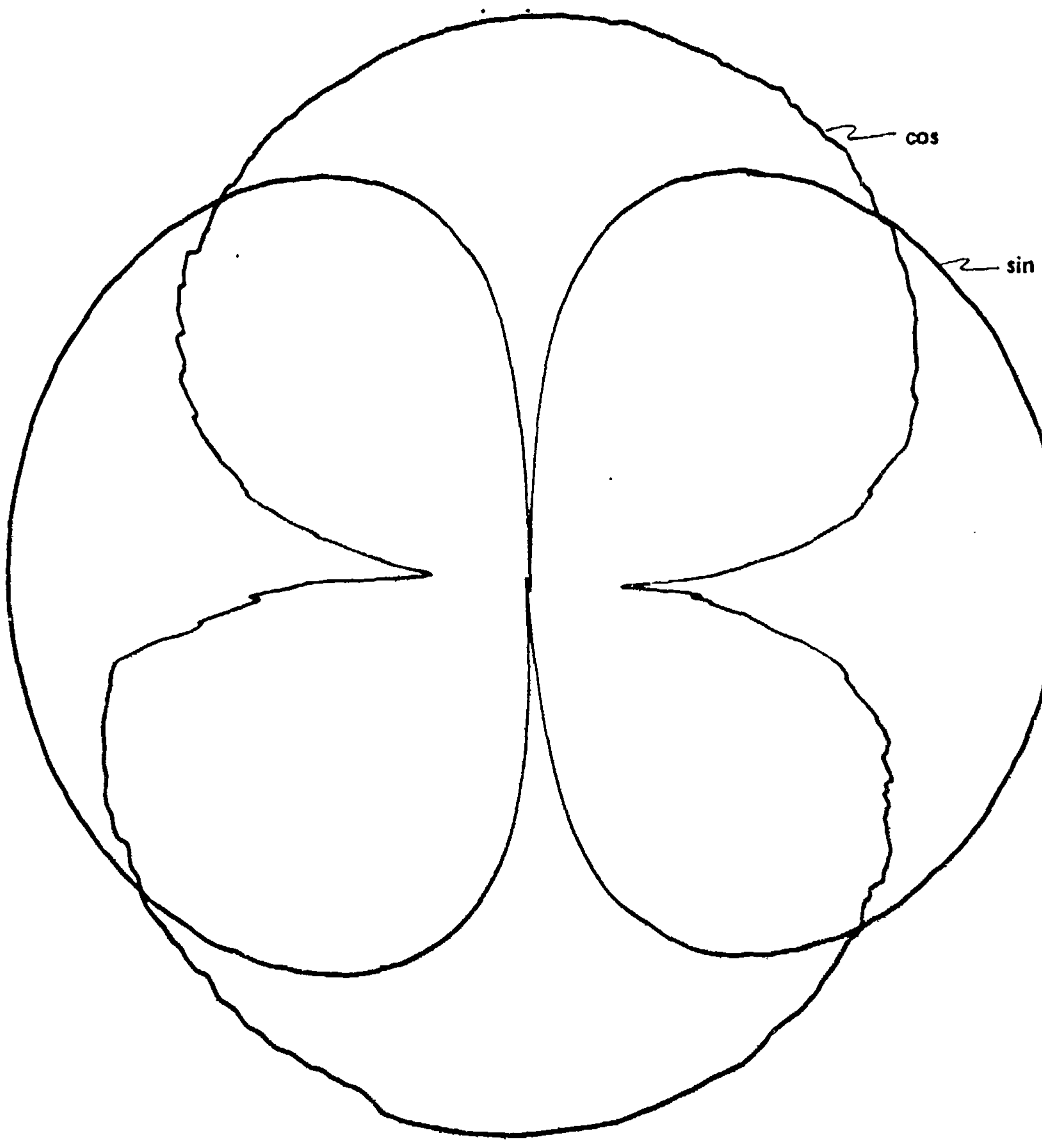
MODE	cw	TEST UNIT	Code 225-1 (AC-1)
PLANE	xy	FREQ/HZ	100
DEPTH	9.2M	DATE	7/13/82
SEPARATION	1M	TST ENGR	RAD

Figure A-12

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



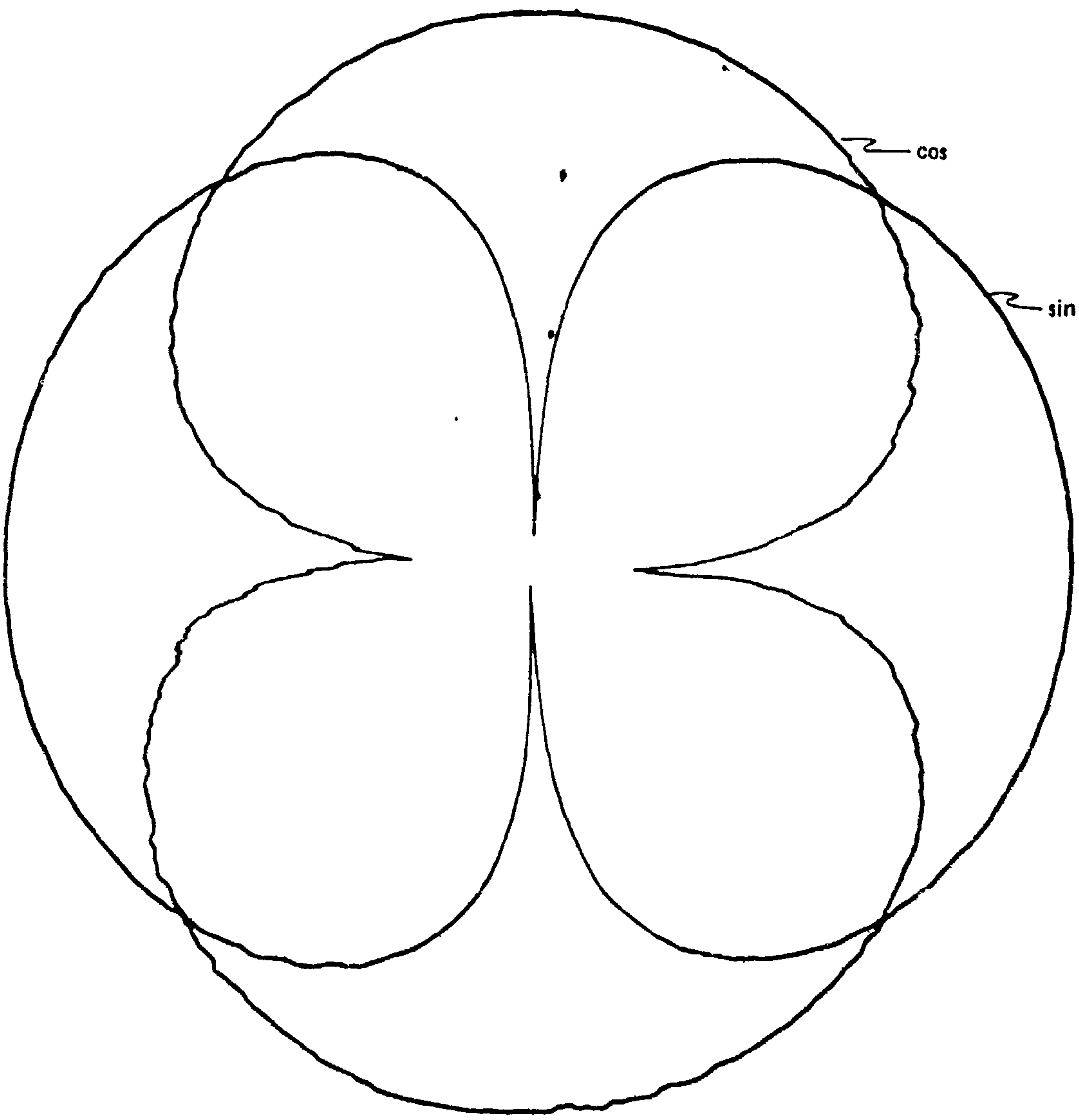
MODE	cw	TEST UNIT	Code 225-1 (AC-1)
PLANE	xy	FREQ/HZ	140 Hz
DEPTH	9.2M	DATE	6/22/82
SEPARATION	1M	TST ENGR	RAD

Figure A-13

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



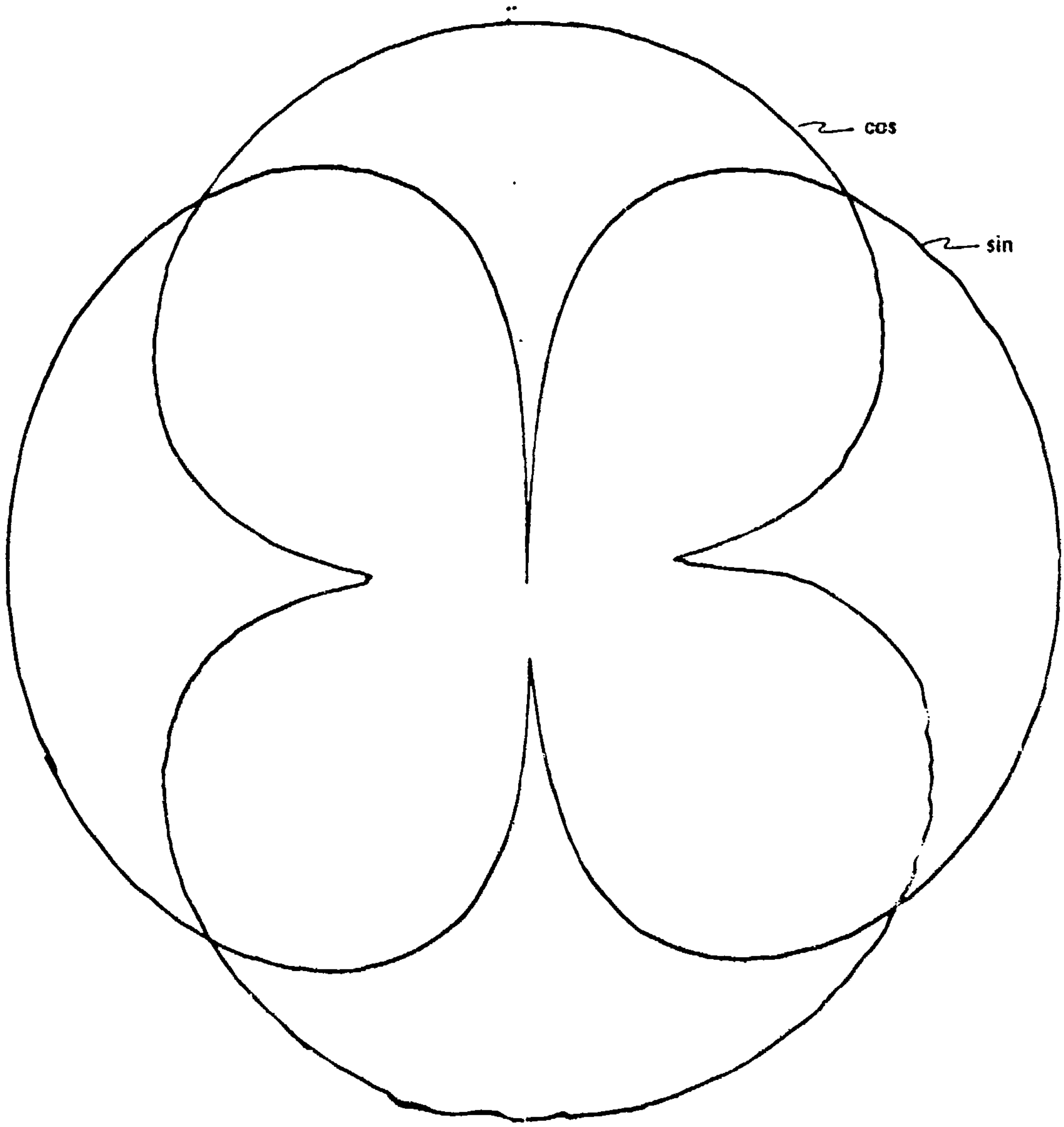
MODE	cw	TEST UNIT	Code 225-1 (AC-1)
PLANE	xy	FREQ/HZ	190
DEPTH	9.2M	DATE	6/22/82
SEPARATION	1M	TST ENGR	RAD

Figure A-14

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



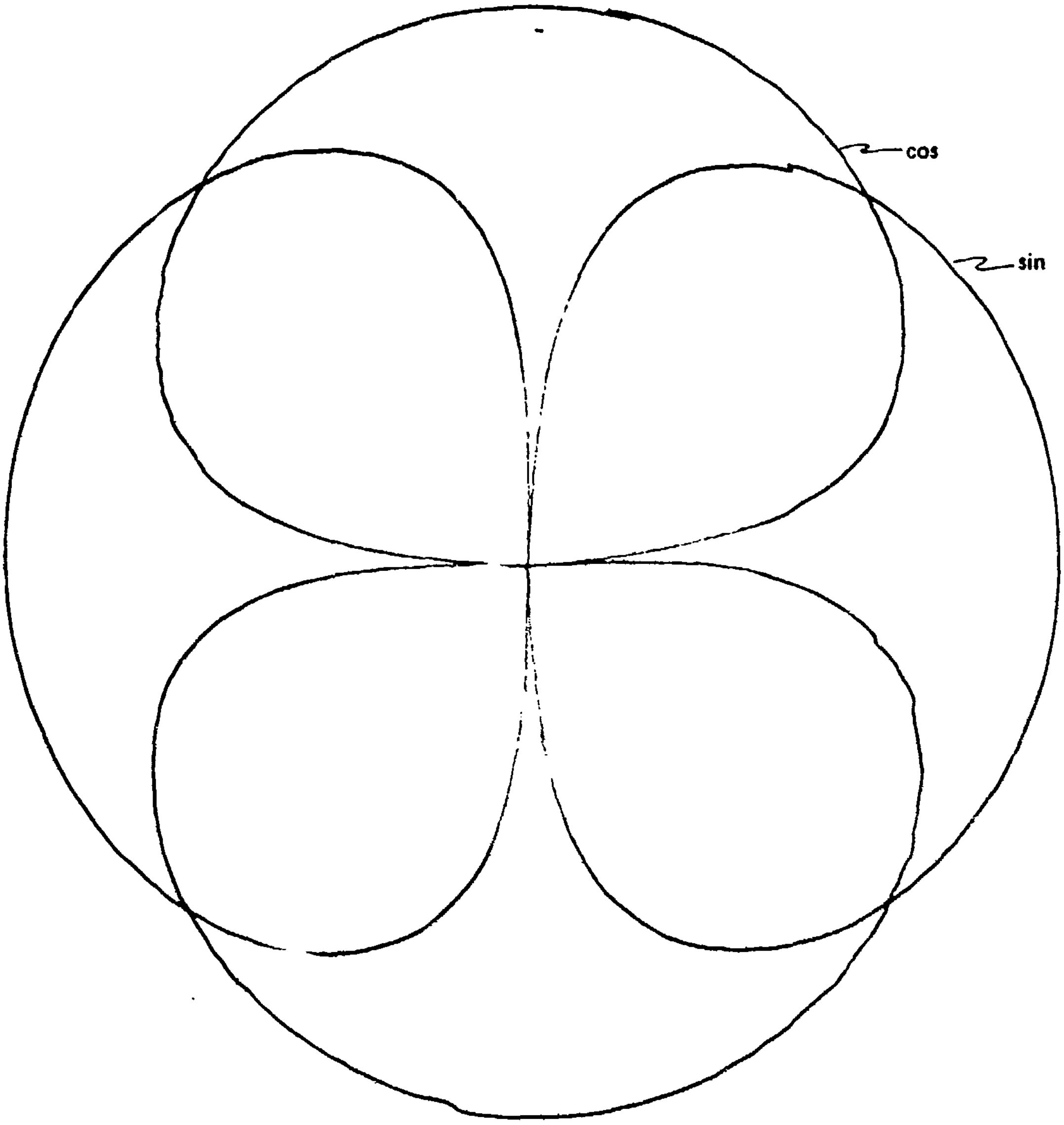
MODE	cw	TEST UNIT	Code 225-1 (AC-1)
PLANE	xy	FREQ/HZ	200
DEPTH	9.2M	DATE	6/22/82
SEPARATION	1M	TST ENGR	RAD

Figure A-15

NAVAL AIR DEVELOPMENT CENTEF
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



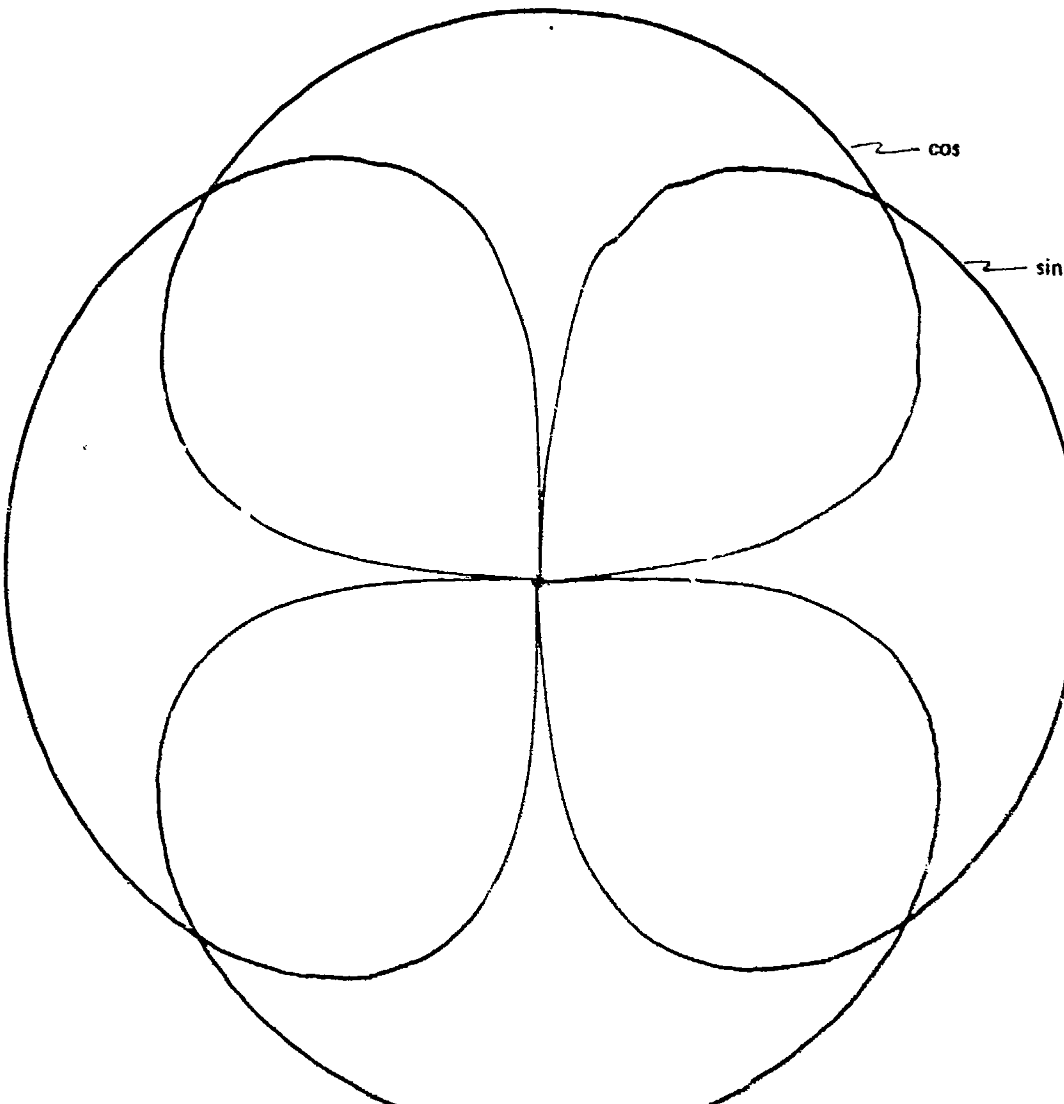
MODE	cw	TEST UNIT	Code 225-1 (AC-1)
PLANE	xy	FREQ/HZ	500
DEPTH	9.2M	DATE	6/22/82
SEPARATION	1M	TST ENGR	RAD

Figure A-16

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



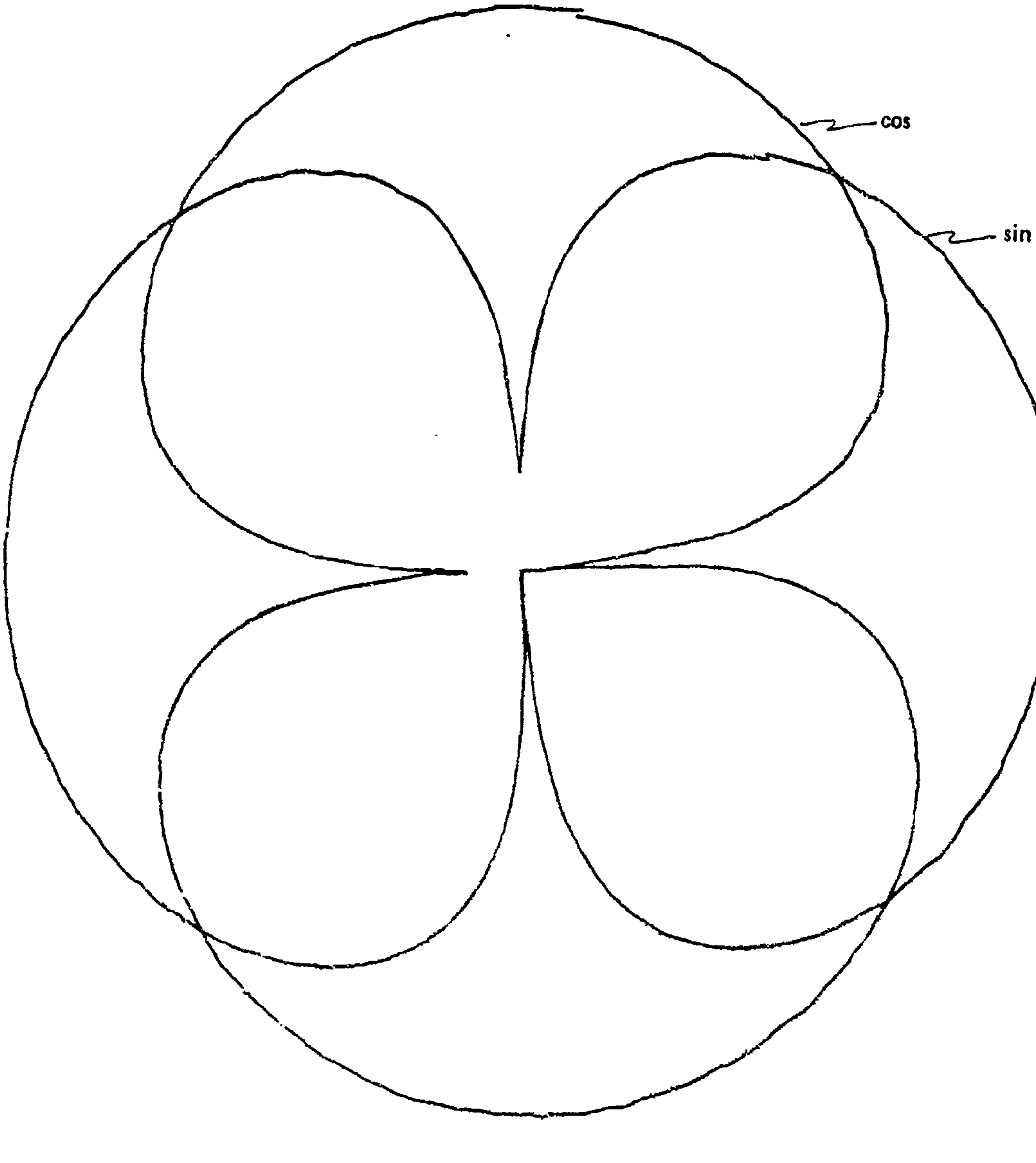
MODE	cw	TEST UNIT	Code 225-1 (AC-1)
PLANE	xy	FREQ/HZ	600
DEPTH	9.2M	DATE	6/22/82
SEPARATION	1M	TST ENGR	RAD

Figure A-17

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



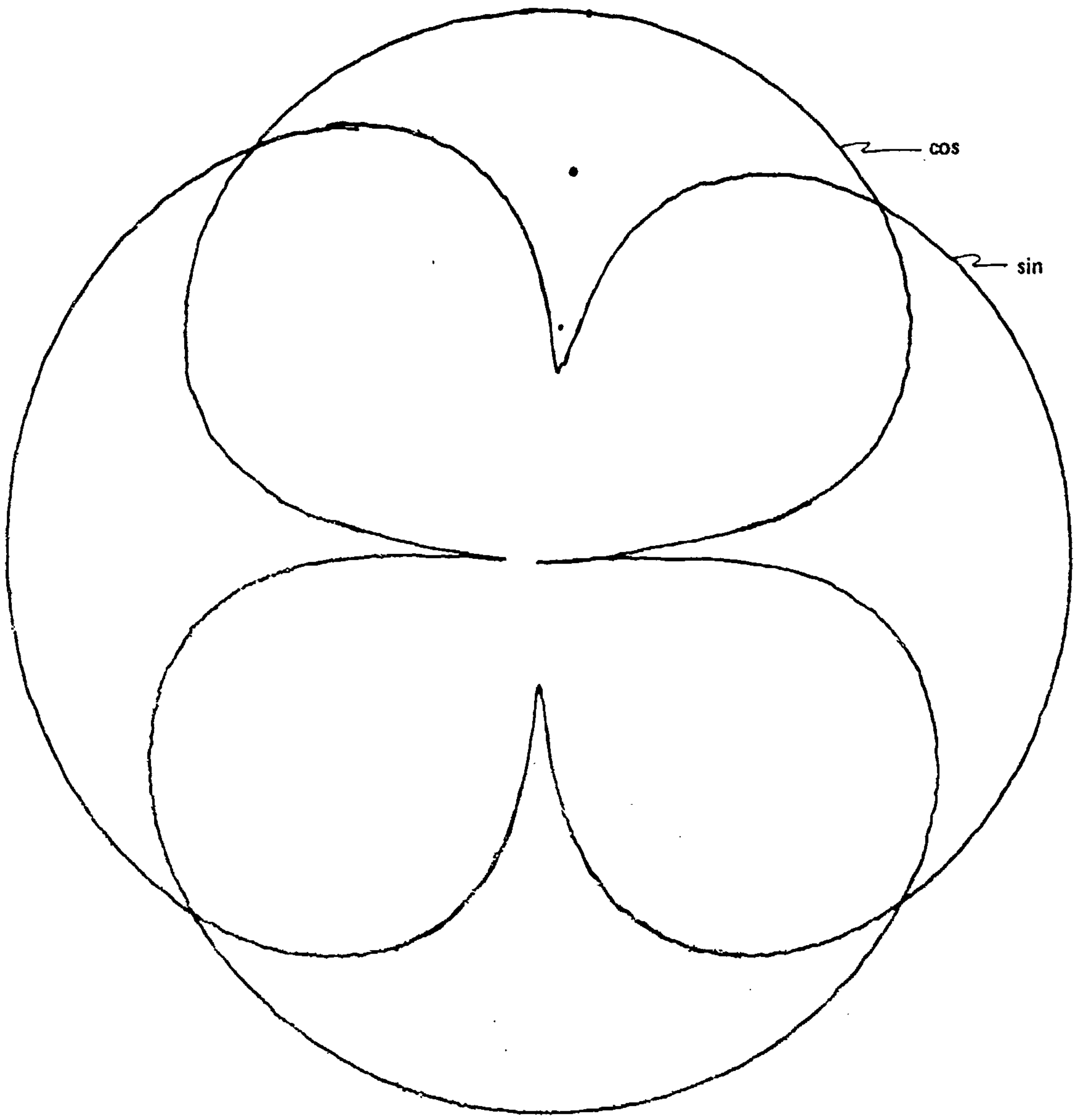
MODE	cw	TEST UNIT	Code 225-1 (AC-1)
PLANE	xy	FREQ/HZ	1000
DEPTH	9.2M	DATE	6/22/82
SEPARATION	1M	TST ENGR	RAD

Figure A-18

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



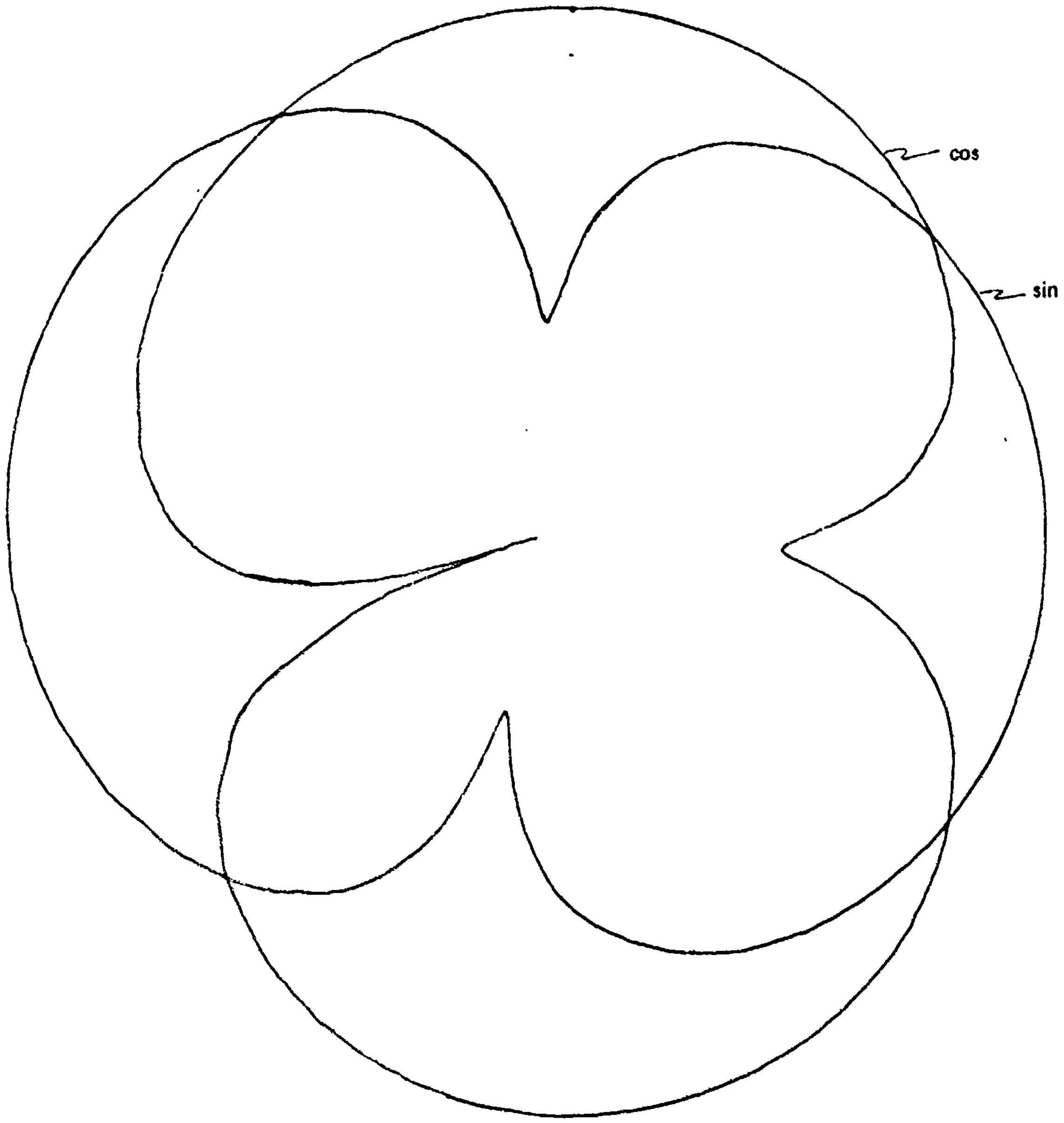
MODE	cw	TEST UNIT	Code 225-1 (AC-1)
PLANE	xy	FREQ/HZ	1500
DEPTH	9.2M	DATE	6/22/82
SEPARATION	1M	TST ENGR	RAD

Figure A-19

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



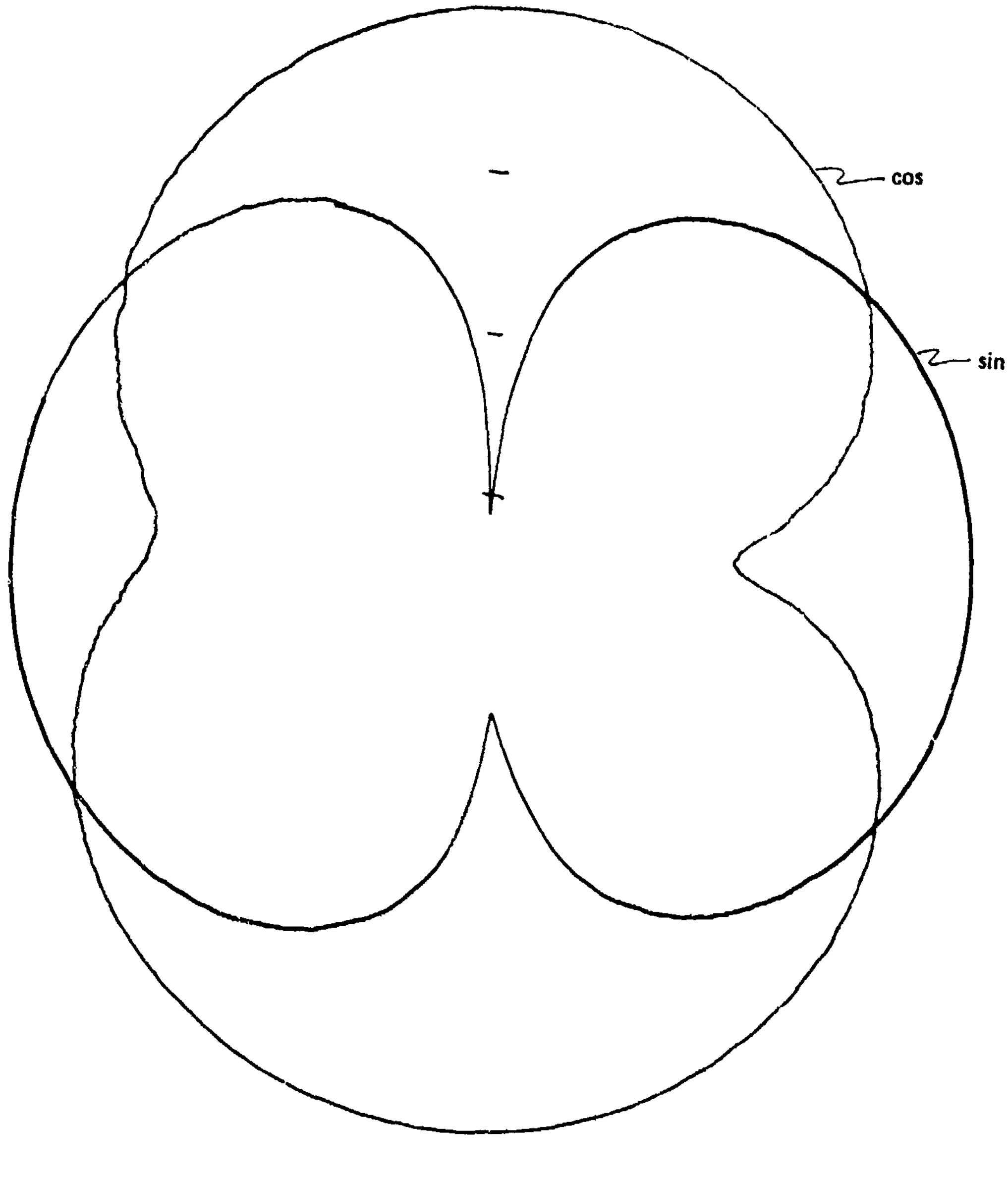
MODE	cw	TEST UNIT	Code 225-1 (AC-1)
PLANE	xy	FREQ/HZ	2000
DEPTH	9.2M	DATE	6/22/82
SEPARATION	1M	TST ENGR	RAD

Figure A-20

NAVAL AIR DEVELOPMENT CENTER
SONAR DEVELOPMENT SIMULATION FACILITIES

RELATIVE DB

OPEN WATER FACILITY
RECEIVING PATTERN



MODE	cw	TEST UNIT	Code 225-1 (AC-1)
PLANE	xy	FREQ/HZ	2300
DEPTH	9.2M	DATE	6/22/82
SEPARATION	1M	TST ENGR	RAD

Figure A-21

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Report Number	Personal Author	Title	Publication Source (Originator)	Pub. Date	Current Availability	Class.
NORDA35VOL.1BK 2OF3	Lauer, R.B.	THE ACOUSTIC MODEL EVALUATION COMMITTEE (AMEC) REPORTS, VOL. 2- APPENDICES A-D-EVALUATION OF THE FACT PL9D TRANSMISSION LOSS MODEL	Naval Ocean R&D Activity	810901	ND ADC034019	U
NORDA36VOL.3BK 2OF3	Lauer, R.B., et al.	THE ACOUSTIC MODEL EVALUATION COMMITTEE (AMEC) REPORTS, VOL. 3- APPENDICES A-D-EVALUATION OF THE RAYMODE X PROPAGATION LOSS MODEL (U)	Naval Ocean R&D Activity	810901	ND ADC034022	U
Unavailable	Hooper, M. W., et al.	MEASUREMENTS AND ANALYSIS OF ACOUSTIC BOTTOM INTERACTION IN THE NORTHWESTERN MEXICAN BASIN	University of Texas, Applied Research Laboratories	811005	ADA107551	U
Unavailable	Kirby, W. D.	FINAL REPORT FOR CONTRACT NUMBER N00014-78-C-0862	Science Applications Inc.	820201	ADA111000	U
Unavailable	Brunson, B. A., et al.	PHYSICAL SEDIMENT MODEL FOR THE PREDICTION OF SEAFLOOR GEOACOUSTIC PROPERTIES	Planning Systems Inc.	820701	ADA119445	U
Unavailable	Cavanagh, R. C., et al.	NORDA PARABOLIC EQUATION WORKSHOP, 31 MARCH - 3 APRIL 1981	Naval Ocean R&D Activity	820901	ADA121932	U
NORDA34VOL.1A	Martin, R. L., et al.	THE ACOUSTIC MODEL EVALUATION COMMITTEE (AMEC) REPORTS, VOL. 1A- SUMMARY OF RANGE INDEPENDENT ENVIRONMENT ACOUSTIC PROPAGATION DATA SETS	Naval Ocean R&D Activity	820901	ADC034017; ND	U
Unavailable	Bartberger, C. L., et al.	THE ACOUSTIC MODEL EVALUATION COMMITTEE (AMEC) REPORTS, VOLUME 2. THE EVALUATION OF	Naval Ocean R&D Activity	820901	ADC034019	U
Unavailable	Deavenport, R., et al.	THE ACOUSTIC MODEL EVALUATION COMMITTEE (AMEC) REPORTS, VOLUME 3. EVALUATION OF THE RAYMODE X PROPAGATION LOSS MODEL. BOOK 2. APPENDICES A-D	Naval Ocean R&D Activity	820901	ADC034022	U
Unavailable	Unavailable	1975-1982 SUMMARY REPORT	Analysis and Technology, Inc.	821217	ADA192591	U
Unavailable	DeChico, D.	ACOUSTIC EVALUATION OF SANDERS ASSOCIATES ACODAC SENSORS	Naval Air Development Center	830301	ADB073873	U
NRL-FR-8695; NRL-8695	Palmer, L. B., et al.	TRANSVERSE HORIZONTAL COHERENCE AND LOW-FREQUENCY ARRAY GAIN LIMITS IN THE DEEP OCEAN	Naval Research Laboratory	830809	ND ADA131916	U
Unavailable	Unavailable	ENGINEERING SUPPORT FOR ACOUSTIC AND ANALYSIS SYSTEM	Systems Integrated	840101	ADB091112	U
Unavailable	Unavailable	SEAS (SURVEILLANCE ENVIRONMENTAL ACOUSTIC SUPPORT PROGRAM) SUPPORT	Systems Integrated	840229	ADB091119	U